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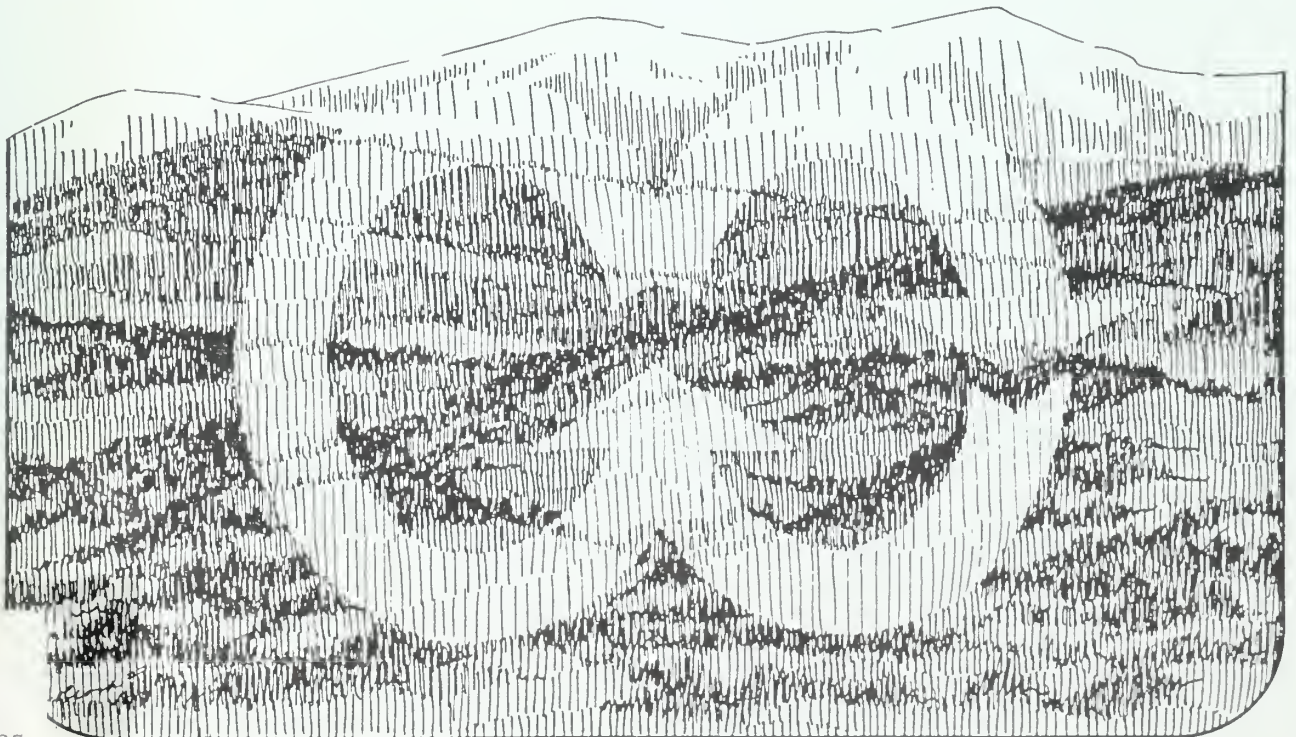
## An Economic Analysis Series For Screening Proposed Timber Management Projects

### REPORT No. 2 Precommercial Thinning Only Lodgepole Pine Site Index 60

by

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FOREWORD

This report (Report #2) is the second of a series of economic analysis reports developed for evaluating and screening proposed timber management projects.

Report No. 1, BLM Technical Note No. 309, was concerned principally with general economic, analytical considerations. It also included an economic evaluation of the costs and benefits obtainable from pre-commercial thinning an overstocked, lodgepole pine stand, growing on a site index 40 site, as compared to the yields anticipated from this theoretical stand - had it remained in a wild, untreated condition.

Report No. 2 deals with an economic evaluation of the costs and benefits obtainable from precommercially thinning an overstocked, young stand of lodgepole pine, growing on site quality 60 forest land. Forest inventory records show that the majority of BLM lodgepole pine forest acreage falls between site indices 40 and 60.

A series of analyses are made, using a wide range of interest rates, timber sale costs, precommercial thinning costs and stumpage prices. The reviewer can make direct comparisons of his actual field condition to the "canned" examples shown in Reports No. 1 and 2. He can then approximate the benefit/cost ratio, present net worth and internal rate of return that would be generated by his proposed silvicultural action.

The forester can also approximate the economic efficiency of his proposal for site indices between exactly 40 (Report #1) or 60 (Report #2) by interpolating between the data given in the "canned" examples. He may also use proportionate extensions of the data given to extrapolate values for site qualities above 60 or below 40. Special precautions must be taken when extending the variables beyond the ranges given because both biological response and discount equations involve logarithmic functions and are not straight line correlations.

If, through this screening, the proposed silvicultural treatment shows promise of meeting minimum efficiency standards, the forester may wish to make an accurate determination of economic values through use of the Denver Service Center IVST Computer Program or through longhand calculations. Mathematical equations for longhand or mini-computer use are given in Report No. 1.

Upon completion of the study of timber values, it is necessary to follow through with an economic evaluation of the impact of the proposed project upon wildlife habitat, range forage, public recreation, watershed values and any other multiple use values impacted.

Management will be in a much better position to make decisions concerning

the distribution and expenditure of limited public funds for increased timber production when information concerning the economic efficiency of proposed projects is available.

## Table of Contents

	Page
Foreword	i
Table of Contents	ii
I. Introduction	1
II. Economic Concepts	4
III. General Considerations	7
IV. The Allowable Cut Effect	10
V. Proposed Precommercial Thinning: Lodgepole Pine - Site Index 60	12
VI. Analysis of Costs and Incomes	18
VII. IVST Computer Input Forms	22
VIII. Analysis of Incomes and Expenses	27
IX. Interpolation Procedures	78
X. Endorsement of Projects	81



## I. Introduction

Considerable attention has been recently focused on both the present and future supplies of industrial timber in the United States. Demands for industrial timber products have been steadily increasing the past few decades; further substantial increases in demands for wood fiber are anticipated.

A portion of the foreseeable demands for commercial timber may be met through increased growth rates of young timber stands. Increased productivity can be obtained by making investments in intensive forest management practices, while maintaining an acceptable forest environment.

One of the most dramatic methods of increasing the supply of timber, in the Rocky Mountain States, is to invest in the precommercial thinning of dense, seedling and sapling size stands of lodgepole pine. Many of these young stands are: (1) heading toward varying degrees of stagnation; (2) will occupy large acreages for long periods of time; (3) costly to hold and protect; (4) provide a haven for insects and disease, and (5) will generally add little to the nation's overall timber supply or other multiple use benefits without specific silvicultural treatment.

### A. Program Objective

The Bureau's management authority is set forth in the Federal Land Policy and Management Act of 1976, (Public Law 94-579) and other Federal Acts. Specific program objectives are spelled out in the Planning Section of the Bureau Manual System (Sections 1601-1608), and the Code of Federal Regulations (CFR-43; Public Lands, Interior).

The Bureau's timber management program encompasses all activities associated with; (1) resource inventory; (2) timber management planning; (3) maintenance of healthy, vigorous forests; (4) forest protection, and (5) the production, offering, sale and non-sale disposal of timber and other vegetative products from the public lands.

The economic potential of a proposed silvicultural action should be evaluated before objectives procedures for program orientation are fully developed. Limited public funds cannot be obligated for timber stand improvement work, such as thinning overstocked timber stands, on the basis of biological needs or the well-being of individual trees or entire forest stands just because "the trees need it".

A fundamental principle of public policy and the use of public funds is to aim toward the maximization of social welfare, as identified by the administration in power. Our national policy, as described by the President's Water Resource Council on Water and Related Land Resources, appears to be "an equitable distribution of real income, employment, and other social opportunities for an optimum level of social well-being". Increases in social welfare, through expenditure of public funds, are said to occur if some people are better off, and no one is made worse off by the proposed action.

Investments into forest management programs must produce a social good which is at least as attractive as the social good produced by other competing public programs. The production of a larger timber supply, resulting in lower cost lumber for the nation's housing program is termed a socially desirable action.

These economic studies are based on developing the present-net-worth of a series of benefits and costs of a precommercial thinning in lodgepole pine forest stands. A benefit/cost ratio is then computed for various interest rates and time frames. Varying time frames between expenditures and the returns obtained therefrom are of the utmost importance. The discount rate, which brings benefits and costs to an initial point in time, is also a critical item; so is the biological response anticipated through different intensities of management on low, medium and high site quality land.

#### B. Purpose

The purpose of this report is to provide an economic evaluation tool for screening proposed precommercial thinning of dense seedling and sapling size stands of lodgepole pine on site quality 60 forest land.

The principal portion of Report Number 1 covers general economic analytical considerations. It is suggested that persons responsible for developing package proposals of timber-stand-improvement-projects review Report Number 1 (Technical Note #309) prior to following the analysis of benefits and costs developed in this publication. Report No. 1 also contains the methodology for making an economic evaluation of precommercial thinning lodgepole pine on site index 40 land.

The forester can examine actual field conditions such as site quality, increased allowable cut, precommercial thinning costs, timber sale costs, and timber sale returns. He can then compare his figures directly to a set of the "canned" solutions and arrive at an approximate benefit/cost ratio (if the situation fits). He may have to use single or double interpolation procedures to develop intermediate values for sites between exactly 40 or 60 as given in Reports Number 1 and 2. Use graphic or mathematical extrapolation procedures for sites below 40 and above 60.



Extrapolated figures should be used very cautiously since growth and yields are not straight line functions of site quality and stand age.

Under direct discount procedures and high rates of interest, long term forest investment projects cannot mathematically compete for scarce or limited funds with short term high yielding projects on a one to one isolated investment basis. A forest property is an ongoing business concern with annual costs and incomes. Reforestation, thinning and other silvicultural projects are treated as annual business costs and are charged against timber income obtained from harvesting a different acreage within in forest.

The Allowable Cut Effect (ACE) concept is used in determining the present net worth and benefit/cost ratios of intensive forest management practices. The allowable cut effect is discussed in detail in Chapter IV.

## II. Economic Concepts

### A. Economic Experiences

Mankind experiences both cooperation and opposition by nature in attempting to increase the output of desirable forest products. Forests and forest ecosystems exist independently of, in spite of, and because of man's efforts.

Under the natural and physical laws of increasing costs and diminishing returns, a relatively small investment in thinning a few overstocked timber stands will give large returns from the investment. As additional, less favorable, acreages are treated, the cost per acre increases and the anticipated returns are reduced. A point is soon reached where requests for funding additional thinning projects are strongly challenged by the opposition, i.e., those who can offer as good or better trade-off advantages for capital and labor.

The concepts of marginal utility, marginal analysis, investment opportunity costs, equilibrium price, market imperfections, etc., may be found in any number of textbooks and other publications. Only a few economic terms will be explained in detail in this publication. Most people recognize the intent and implication of classic economic theory when given an example, such as: (1) How much would a thirsty person pay for his first glass of water? (2) How much for the second? The third, etc.? This is "marginal utility", i.e., the worth of one more item of a series of items for sale. It is important to note, that in general, the larger the supply of timber available the lower the cost of lumber for all national uses.

There is no economic activity or decision carried out by mankind that does not have a trade-off cost. Time, funds, labor, investments, etc., can always be used somewhere else or for a different purpose.

In addition to recognizing present wants (consumption values) mankind has a social consciousness which will allow him to make sacrifices for: (1) himself; (2) his peers and others; (3) for future old age, and (4) for future, unborn generations. Mankind for the most part, also follows a rational line of reasoning. The conclusions reached, however, may differ greatly among individuals and groups.

### B. Compound-Discount Interest Rates

One dollar invested now and compounded annually for 100 years, at three percent interest rate, is \$19.22. The same dollar, if compounded annually for 100 years at an interest rate of ten percent, totals \$13,780.61. This dollar invested at ten percent for 150 years represents a value of \$1,617,717.00. The use of long term, high discount rates of interest for investments in long range forest management

programs thus becomes ridiculous, even though capital appreciation and inflated values of forest products would wipe out some of the differences shown. Forests are managed as on-going business concerns with annual costs and returns and not as a series of one-shot investments in re-forestation, thinning, protection, access, harvesting, etc.

In analyzing the canned examples given in Reports #1 and 2, a wide range of compound-discount interest rates were used. Twenty-five computations, from minus 10 percent to plus 15 percent interest rates, in one-percent increments, are shown. If given a choice, individuals and groups (society) may select interest rates according to the following:

1. Strictly financial goals viewed for a specific action.
2. Social time preference goals:
  - a. Short term social goals.
  - b. Long term social goals.
  - c. Long term social goals with inflationary rates.

Long term social discount rates cannot reach zero, but they may not be as high as the ten percent inflation rate mentioned by the news media. Refer to BLM Manual 9520, Methods of Economic Analysis for Policy Statements Concerning Use of Discount Rates.

The discount rate for BLM resource projects which will normally be used is the "Water and Related Land Resource Council" rate that is now published annually and distributed to BLM field offices via information memoranda. This rate is based on the average rate of interest payable by the Treasury on long term, interest bearing, marketable securities of the United States. Refer to U. S. Department of Interior Manual (700 - USDI) for Departmental policy statements concerning resource management projects.

### C. Investment Criteria

The Bureau's IVST computer program may be used for evaluating forestry opportunities under three basic investment criteria: (1) present net worth (PNW); (2) benefit/cost ratio (B/C Ratio) and (3) internal rate of return (IRR). The uses of these investment criteria are described below:

#### 1. Present Net Worth (PNW)

All future costs and incomes are discounted back to the present using standard discount equations and the desired interest rate. Costs and incomes are thus directly comparable at one point in time.

Refer to Report #1, Chapter VI, page 12 for use and manipulation of the compound-discount formulas.

## 2. Benefit/Cost Ratio (B/C Ratio)

The benefit/cost ratio is a mathematical expression of the present net worth of all benefits divided by the present net worth of all costs. Benefit/cost analysis should be used for all projects where the interest rate (discount rate) is mandated by law or regulations. All projects which include multiple use resource impacts must be analyzed under this criteria. Individual multiple use values and costs must be compiled; then each must be reduced to a common denominator (present net worth) under approved discount rates of interest.

## 3. Internal Rate of Return (IRR)

The rate of return analysis or internal rate of return is a technically sound method that, when properly applied, will give the same results as the benefit/cost method.

The internal rate of return analysis should be used whenever: (1) The interest rate is unspecified and (2) an interest rate is allowed to be found where the benefit/cost ratio is exactly 1 to 1. This method requires the decisionmaker to specify a rate of interest that he will compare the rate of return with (e.g., market rate of interest in making a decision as to a projects feasibility).

This method should also be used whenever funds are a limiting factor. It will assure that discounted net returns equal or exceed the cost of obtaining a desired level of benefits. The IRR method is often used to compare two or more methods of accomplishing the same job for the least actual cost or other cost-effectiveness criteria.

### III. General Considerations

#### A. Increased Timber Products

As noted in the Preface and Chapter I, Reports #1 and 2 are concerned with precommercial thinning only. Additional reports are planned in which other types of silvicultural treatments will be analyzed.

Management must view the overall objectives of multiple use and timber production in developing and funding programs to effectively utilize natural resources, manpower, available funds, energy and knowledge in attempting to meet the goals of forest land management. Increased timber production, one of the stated goals, can be accomplished by one or more of the ways listed below:

1. Shorten the length of time required to fully regenerate a denuded forest.
2. Shorten the precommercial growing period and the time it takes to grow a commercial size product.
3. Improve the capability of the site to produce larger crops through fertilization, irrigation, reduction of competing vegetation, use of improved genetic stock, etc.
4. Maintain or improve productivity levels of the forest through forest protection programs for reducing the adverse effects of wildfire, insects, disease, windstorms, trespass, animals, etc.
5. Improve the utilization of existing stems and through periodic harvesting of salvage and mortality trees.
6. Improve the stand structure by maintaining fully-stocked stands of desirable species.
7. Improve the forest structure through development of an idealized distribution of age classes.
8. Increase the productive forest land base by raising the productivity of lands formerly classified as submarginal.

NOTE: It is beyond the scope of this paper to discuss accelerated liquidation of old growth as a means of increasing current harvest levels.

## B. Future Management Options

A forest is a living, growing entity. It is continually changing, sometimes with dramatic results. Overstocked young stands of some species soon reach a biological and physiological condition of stagnation, insect and disease susceptibility, deterioration, etc., from which recovery is nearly impossible. Investments in timber management and stand improvement projects will give us future management options that we or future generations would not otherwise have if the stand were left to develop in a wild, unmanaged condition.

This report does not attempt to indicate the level of output achievable from the forest or the level of output that produces the most economical rate of return on funds invested. These management decisions on how much to spend and where to spend it, are a product of the planning, programming and budgeting systems.

## C. The "With-Without" Concept

An accurate analysis of a thinning proposal requires an intensive, site specific inventory. Site quality and habitat studies are also required. Stocking tables, stand tables, height and radial growth projections and other equations must be developed for the existing stand for forecasting future development of the stand - if it were left in an untreated condition. These growth and volume projections represent the base or "without" treatment condition.

Silvicultural prescriptions may be developed for various thinning levels or thinning intensities. The silviculturist requires the same basic information concerning stand attributes for developing growth and yield projections for stands "with cultural treatment applied" as he does for the "without" level of management. Refer to BLM 5611, Lodgepole Pine Silvicultural Manual for the details of developing a stand prescription. The development of the prescription and future yields anticipated (as a result of treatment) should be the responsibility of a qualified silviculturist, using approved stand-growth-simulation-modeling procedures.

The third step requires the development of an economic evaluation report of the relative efficiency of the project to pay for itself. Reliable estimates of the costs and returns are required. These can be defined as follows:

### (a) Costs:

- Direct cost of the practice proposed.
- Costs foregone, which are normal operating expenses that you no longer have since you put the proposal into operation.

(b) Income:

- Dollar values of the expected increase in income due to the project.
- Income foregone, which is the income that you no longer have since you put the proposal into operation.

Secondary costs and incomes should not be included in the initial analysis phase.

D. Screening Procedure

Evaluations of thinning site qualities 40 and 60 (50-year base) may be made directly by consulting the data given in Reports #1 and #2. An evaluation of thinning any site quality level from 30 to 70 may be made by plotting appropriate data from Reports #1 and #2 onto a single overlay and interpolating the results for most individual situations. This screening process will produce present net worth and benefit/cost data sufficiently accurate for general use.

The straight line interpolation method assumes that site responses, growth and yield, productivity and compound-discount, equation returns are straight-line functions. This is not true; all of the above are logarithmic functions. However, the shape of representative curves such as for stand volume over stand age, are generally well known by foresters. The straight-line projections can be "bent" into appropriate curves by the user if he feels his curved adjustment is uniformly applied and they more accurately fit his particular situation.

Projects which appear feasible may then be examined in detail through the use of computerized models. A considerable amount of time and savings can be realized by initially excluding those proposals which do not have a chance of survival.

#### IV. The Allowable Cut Effect

The Bureau's forests are managed under the sustained yield, non-declining, even-flow concept of timber management. Projects which accelerate growth of immature stands, reduce reforestation lag, increase utilization levels, add acreage to the commercial forest land base, etc., will permit an increase in the rate at which mature timber may be harvested. This direct impact upon the harvest level is termed the allowable cut effect (ACE). It occurs when projects are planned or performed. Benefits may occur immediately upon acceptance of that allowable cut level of management by appropriate officials. Acceptance of a fixed harvest level infers that the cultural efforts built into the system will be budgeted and carried out during that decade. If, for any reason, planned projects are not carried out, the harvest level must be reduced; otherwise, timber reserves are over-drawn and the sustained yield, non-declining policy is violated.

This publication assumes that the full (100 percent) level of impact upon the allowable cut is credited directly to mature timber available for harvesting. This volume deficit from heavier cutting, will be replaced with the increased volume generated through growth on the treated acreage when the treated stand has matured and is finally harvested.

The allowable cut effect is valid under the following conditions:

1. Constraints such as even flow, non-declining, sustained yield, harvest levels are applied to the forest property.
2. A surplus of mature and older age class immature timber exists in the unit. The mature timber must carry the project until the treated stand is available for final harvest.
3. Harvest ages are flexible and are not predetermined as necessary if acreage regulation were used to develop a regulated forest property.

The true impact of a stand improvement (thinning) project can only be determined by operating the forest simulation model (SIMMIX) under the "with-without" levels of biological response.

An analysis of the URA 3, URA 4 and MFP 2 potential yield, forest modeling runs for the inventory unit will indicate the amount of direct impact, allowable cut credit available. Where full allowable cut effect credit cannot be taken, adjustments must be made in the appropriate cost and income columns of the input data.



It must be noted that not all proposed thinning projects will result in an increased recoverable volume. Thinnings designed to increase wildlife habitat, livestock forage, recreation potential, water production, disease reduction, etc., may actually reduce the growing stock level to a point where timber production would be less than that received from an unthinned stand. Heavily stagnated stands may not be able to recover from the shock of a heavy thinning. They may deteriorate further and lose what potential they had to produce wood products.

V. Proposed Precommercial Thinning: Lodgepole Pine - Site Index 60

A. Present Situation

The forest contains a considerable acreage of 10, 20 and 30 year old stands of lodgepole pine. Site quality of these acreages vary from 30 to 70 based on total height of dominant trees at 50 years of age. Much of the acreage is heavily overstocked. These seedling and sapling size trees are approaching a stagnation phase from which many will never recover if left untreated.

B. The Problem

What should be done with these dense young stands? Management has several options:

1. Leave the stands alone except for normal protection efforts.
2. Leave the stands alone, but place them in a "let burn" category by planning firelines outside their boundaries if or when wildfire threatens.
3. Thin, weed, clean or otherwise remove those stems which are competing with selected, potential crop trees.

An option available to the manager of older, stagnated, diseased or mistletoe infested stands is to destroy the stand. He can then regenerate the area with the same or different species.

This option should be analyzed very carefully. Not only are the past years of volume and growth wiped out, but forest regulation and allowable cut computations are affected.

C. Stand History and Biological Concepts

Lodgepole pine is prone to overstocking and subsequent stagnation because of silvicultural characteristics common to "fire" species.

Overstocked stands generally result from the effects of wildfire. As the ground fire consumes litter and duff, an ideal seedbed of mineral soil is exposed. Grass, forbs and brush are burned off, thus removing these competitors from the growing space. Most of the viable seed of all species which has been stored in the duff, is also consumed by the fire.

Lodgepole pine commonly exhibits cone seroteny (closed cones). These persistent, closed cones contain an accumulation of many years of seed production. Temperatures of over 115° F. melt the resin bonds of

serotinous cones, thus allowing them to open and shower their seed upon the freshly prepared seedbed.

The burned organic matter releases calcium and other mineral nutrients which raise the ph of acidic forest soils. Seedlings germinate and grow better in soils which are slightly acidic than they do in highly acidic soils. A portion of the present population of mice, insects, diseases, fungi and other organisms which may attack seed and emerging seedlings are destroyed by the groundfire. The seedlings thus have an excellent chance for survival.

Trees killed or damaged by fire generally remain standing for some time. They provide partial shade, which is very essential to seedling establishment, especially on hot dry slopes. They also provide some protection against drying air currents. As needles and small limbs drop from the standing dead trees, an excellent mat is formed which protects the soil from excessive surface erosion.

Under the ideal biological conditions described above, many thousands of seedlings per acre may become established. Within a few years their roots will occupy most of the underground space and their tops will form a 100 percent crown cover.

Under high stand density conditions, lodgepole pine has a tendency to form root grafts. It is the author's hypothesis that very few of the seedlings will be able to express their dominance because higher concentrations of nutrient solutions of the more vigorous stems are parasitized by their neighbors through the root grafts. No research, however, has been found to substantiate this theory.

The end result is often dense stagnated stands upwards of 50,000 stems per acre. These stands provide excellent wildlife cover; however, they will add little, if anything, to the timber productivity of the forest or the nation's timber supply.

Silvicultural characteristics and biological response may vary considerably between species, among genotypes of the same species and between stands of similar genotypes growing at different degrees of stand density and on different sites.

A heavy precommercial thinning in a very dense stand may cause an opposite reaction from the treatment from what is intended. Residual trees are subject to sunscald, wind throw, and snow breakage. They become the selected targets of porcupines and other animals. Insect epidemics can be initiated in the fresh slash, and dried slash creates an extreme fire hazard. It is suggested that qualified silviculturists examine the proposed thinning area before attempting to design a treatment prescription.

Researchers have pointed out that to be most effective in terms of individual tree growth, precommercial thinning must be accomplished before the crown length is reduced to 40 to 50 percent of total tree height and the vigor of selected crop trees is likewise reduced.

The timing factor to meet this requirement becomes increasingly more important at higher stand densities as the effects of stagnation intensify. The physiological condition of the stand is probably more important than actual stand age because it represents the ability of the stand to biologically respond to treatment.

#### D. Timber Stand Prescription

A detailed prescription was prepared for a theoretical 20 year old stand of lodgepole pine on site quality 60 (50-year base) forest land. As shown on Table 1, page 15, the stand is expected to produce approximately 4,000 board feet of timber, at 100 years of age, if left in an unmanaged condition.

With a single precommercial thinning (at age 20), we can anticipate an increase of 30,400 board feet for a total yield of 34,400 board feet, at 100 years of age. The thinned stand represents an increased average annual increment of 304 board feet, per acre, per year, over that expected from a stagnated, unmanaged stand. Volumes are computed by using the International 1/8 inch (saw kerf) Log Rule for all trees 6.0 inches dbh and larger, to a 5.0 inch top.

If the Scribner Variable Top Log Rule is used, the yield per acre realized will be approximately 1/2 of that obtainable under the International Log Rule. A tree must measure eight inches (inside bark diameter) at the top of the first 16-foot log to meet minimum merchantable size definitions for the variable top volume equation.

At 100 years of age, stand attributes of the thinned stand are expected to be:

- number of trees per acre = 410
- average DBH = 10.1 inches
- average height growing stock = 78 feet tall
- total basal area = 220 square feet per acre
- form class = 0.80

At 100 years of age, the unthinned stand is expected to contain over 1,400 stems per acre, averaging five inches in diameter. Total cubic foot volume of biomass in the unthinned stand will be greater than

TABLE #1

## YIELDS PER ACRE OF LODGEPOLE PINE-SITE INDEX 60-(50 YEAR BASE)

Precommercial Thin at 20 Years of Age Only <sup>1/</sup>

Stand Age in Years	Unthinned <sup>2/</sup> Stagnated Stand Bd.Ft./Acre	Thinned <sup>3/</sup> Stand Bd.Ft./Acre	Increased Difference due to Thinning	
			Volume/Acre Board Feet	M.A.I. Per Acre Board Feet
		Thin at 20 years of age		
20	0			
30	0	3,000		
40	0	8,700		
50	0	15,100	15,100	302
60	800	22,000	21,200	353
70	1,600	27,400	25,800	369
80	2,400	31,200	28,800	360
90	3,200	33,200	30,000	333
100	4,000	34,400	30,400	304
110	4,800	35,050	30,200	275
120	5,600	35,550	29,950	250

<sup>1/</sup> The sample yield table shows harvestable volumes anticipated from a lodgepole pine stand in an unthinned, stagnated condition as compared to the expected results from this stand if it were thinned to a 10'x 10' spacing. International Log Rule, 1/8' saw kerf, 6.0" minimum d.b.h., 5" fixed top. (Prescription developed at the Service Center; 1970).

<sup>2/</sup> The volume anticipated from an unthinned, stagnated stand of lodgepole pine is predictable only if the past history of number of stems per acre, basal area, diameter increment, the year when their crown competition factor reached 100, 200, 300, etc., and other stand attributes are available.

<sup>3/</sup> The yields shown represent a 10 percent reduction of the yield anticipated from an idealized stand prescription.

the volume produced by the thinned stand. Useable or merchantable volume, however, is much greater from the thinned stand because growth is concentrated onto a few crop trees instead of being distributed among many non-merchantable size stems.

Lumber recovery ratios of board feet per cubic foot of timber rise rapidly as tree diameter increases. Less than two board feet per cubic foot is obtainable from eight-inch diameter trees, while an average of five board feet per cubic foot can be ~~sawn~~ from trees 14 inches in diameter. Very large trees can produce eight to nine bd. feet per cubic foot of harvestable volume.

#### E. Increased Annual Allowable Cut

In the sample stand discussed above, the increase of volume generated due to precommercially thinning one acre of site index 60 lodgepole pine is 30,400 board feet (International 1/8" Log Scale). This volume data is based upon harvesting the stand at 100 years of age. Both the increased increment period and the investment period last for 80 years because the stand is thinned at age 20 and harvested at 100 years of age.

The 30,400 board feet of additional volume generated is proportioned over the 80 year investment period. An increased annual allowable cut of 380 board feet may be offered for sale for each acre thinned:

$$\text{Computation: } \frac{30,400 \text{ bd. ft., acre, in.}}{80 \text{ years}} = 380 \text{ bd. ft. annually for 80 years}$$

This increase in the annual cut may be harvested from mature or over-mature timber anywhere within the sustained yield unit.

#### F. Increased Acreage Harvested Annually

Forest inventory records show that mature timber acreages average approximately 20,000 board feet per acre, on sites 55 to 65, within this sustained yield inventory unit.

An increase in the allowable cut of 380 board feet annually will require the harvesting of 0.019 extra acres of mature timber annually for the next 80 years.

Computation:

$$\frac{380 \text{ Board Ft. Annual Cut}}{20,000 \text{ Board Ft./Acre}} = 0.019 \text{ acres of mature timber harvested for each acre that is precommercially thinned.}$$

To fulfill allowable cut requirements, one additional acre of mature timber must be added to the annual cutting budget for each 52.63 acres that are precommercially thinned. (Assume acreage stand volume of 20 m./acre for mature timber and site index 60 for thinned acreage.)

Computation:

$$\frac{20,000 \text{ Bd. Ft./Acre}}{380 \text{ Bd. Ft. Allow. Cut}} = 52.63 \text{ acres}$$

## VI. Analysis of Costs and Incomes

Only the direct evident costs and incomes dealing with timber production are addressed in this technical note. Secondary, benefits and costs, while real, are not considered in any of the computations.

In making an evaluation of a proposed thinning project, we must first assume that a forest management program is presently in operation. This on-going forest management program is also assumed to be operating at the base (zero) level or "without" intensive management level of operations.

Any change in the program level, such as adding a timber stand improvement project, will result in changes in some costs and incomes over the effective life of the project.

Some other cost and income levels may not be directly affected. Average fire protection costs, for example, will not be affected by a thinning project unless an extreme slash hazard problem is created. Protection costs for extreme slash hazard areas are relatively high. However, after the slash deteriorates, a much lower than average hazard exists on the area.

### A. Initial Thinning Costs

Precommercial thinning costs vary greatly depending upon the method used, initial stand density, the size of the trees to be removed, topography, and the disposition of the slash. These costs may range from less than \$25.00 per acre for strip thinning by walking a tractor through the stand, to over \$125.00 per acre for hand thinning very dense stands.

In the sample computations, initial precommercial thinning costs of \$25.00, \$50.00, \$75.00 and \$100.00 per acre are used in preparing the graphic and tabular exhibits. The initial precommercial thinning cost is a direct input into the "canned" presentation. It represents an immediate expense at the very beginning of the investment period. Discount rates of interest have no affect upon the precommercial thinning cost.

### B. Costs of Selling Additional Timber

The allowable cut increment of 380 extra board feet of timber for an 80-year period, produced by thinning one acre, results in a direct administrative cost for selling this timber. The sale area must be made slightly larger and the timber cruiser must cruise, record and process additional data, etc. All of the costs of processing and administering a sale are prorated by the total volume sold. Selling costs may be determined for a state or districtwide area, over a five-year period of time to eliminate the variances found in annual programs.



1. If the average cost for selling mature timber in the District is \$5.00 per MBF, then the annual cost for selling the 380 extra board feet is \$1.90 for each acre thinned.
2. If the average cost for selling mature timber in the District is \$10.00 per MBF, then the annual cost for selling the 380 extra board feet is \$3.80 for each acre thinned.
3. If the average cost for selling mature timber in the District is \$15.00 per MBF, then the annual cost for selling the 380 extra board feet is \$5.70 for each acre thinned.
4. If the average cost for selling mature timber in the District is \$20.00 per MBF, then the annual cost for selling the 380 extra board feet is \$7.60 for each acre thinned.
5. If the average cost for selling mature timber in the District is \$25.00 per MBF, then the annual cost for selling the 380 extra board feet is \$9.50 for each acre thinned.

C. Income From Selling Extra Timber

In this example, the annual sale of the extra 380 board feet of mature timber for each acre that is precommercially thinned, will result in an annual income for the next 80 years. This annual income will vary according to the going price of stumpage.

In developing the graphic and tabular exhibits, timber values of \$5.00, \$10.00, \$20.00, \$40.00 and \$80.00 per thousand board feet are used. This doubling procedure allows for the construction of proportionate points between evenly-spaced lines on the graphic exhibits.

The total income from a timber sale consists of both the cash value received for the stumpage harvested and the dollar value of capitol improvements, such as roads, bridges, culverts, reforestation, etc. accomplished under the terms of the timber sale contract. The selling price under these situations does not represent the full value received for timber purchased.

1. When the average value received for mature timber in the District is \$5.00 per MBF, then the annual recurring income for the 80-year investment period is \$1.90 for each acre that is precommercially

thinned.

2. When the average value received for mature timber in the District is \$10.00 per MBF, then the annual recurring income for the 80-year investment period is \$3.80 for each acre that is precommercially thinned.
3. When the average value received for mature timber in the District is \$20.00 per MBF, then the annual recurring income for the 80-year investment period is \$7.60 for each acre that is precommercially thinned.
4. When the average value received for mature timber in the District is \$40.00 per MBF, then the annual recurring income for the 80-year investment period is \$15.20 for each acre that is precommercially thinned.
5. When the average value received for mature timber in the District is \$80.00 per MBF, then the annual recurring income for the 80-year investment period is \$30.40 for each acre that is precommercially thinned.

#### D. Reforestation Costs

The sale of the extra 380 board feet of timber (allowable cut effect), from precommercial thinning one acre, results in an extra 0.019 acres of clear-cut forest area annually for the 80-year investment period.

Natural regeneration usually occurs on high-site, small, clear-cut acreages of lodgepole pine. Therefore, we have not included reforestation costs in this series of "canned" examples. However, if reforestation costs are necessary, prorate the entire reforestation cost for the District by the total acreage that is final harvested to determine the average regeneration cost per acre.

Assume that you must reforest the extra 0.019 acres of cut-over at the same proportionate rate as the rest of the District cut-over area. For example:

If forest regeneration records show that 1/10 of the cut-over acreage requires planting (at a cost of \$100.00 per acre), then the average reforestation cost is \$10.00 per acre. At an average cost of \$10.00 per acre, it would cost \$0.19 annually to reforest

the 0.019 acres of cut-over land which is generated annually from every acre that is thinned. Note that the reforestation cost shown above is equivalent to increasing the cost of offering the additional 380 board feet of timber for sale by \$0.50 per thousand board feet.

Under extremely adverse conditions, one-half of the acreage harvested annually may need regeneration assistance. When reforestation costs \$100.00 per acre, the average cost would be \$50.00 per acre. The cost of reforesting 0.019 acres would then be \$0.95 annually for the next 80 years for each acre thinned. You could then add \$0.95 to the cost per thousand board feet of offering timber for sale and plot the sum on the appropriate graph.

## VII. IVST Computer Input Forms

The following four pages show a set of IVST input forms. The handwritten input data shown is exactly as used in Chapter VIII to develop present net worth and benefit/cost ratio values for the sample problem in this publication.

This set of sample input data covers the following situations:

- Precommercial thinning costs of \$25.00 per acre.
- Selling costs of \$5.00, \$10.00 and \$15.00 per MBF.
- Incomes of \$5.00, \$10.00, \$20.00, \$40.00 and \$80.00 per MBF.

The input data is also used as the code for identifying the results of the analysis shown in Reports #1 and 2.

A code of 25-5-40 indicates:

- The precommercial thinning cost is \$25.00 per acre.
- It costs \$5.00 per thousand board feet to sell timber in the District.
- A value of \$40.00 per thousand board feet was received from the sale of mature saw-timber.











## VIII. Analysis of Incomes and Expenses

This chapter consists of twelve (12) subsections, each containing five sets of present net worth and benefit/cost data. Each of the twelve subsections consists of four pages of data as follows:

- A summary page explaining the five sets of input data and the answers developed for an interest rate of six percent.
- A graphic presentation of the benefit/cost ratio data developed for various percentage rates of interest.
- A graphic presentation of the present net worth values developed for various percentage rates of interest.
- A copy of one page of the IVST computer output sheet showing the present-net-worth and benefit/cost ratios for interest rates from -10% to 15% in one-percent increments.

The tables and graphs represent the economic efficiency of precommercial thinning the site index 60 lodgepole pine stand discussed in Chapter V. Cost and income input data are set at regular geometric intervals for ease in interpreting intermediate values.

The observer can fit data obtained from actual field conditions proportionately between lines on the graphic examples. An approximate present-net-worth and benefit/cost ratio can be observed without having to do the actual computations. The details for making a single or double interpolation between the fixed data herein and in Report #1, are covered in Chapter IX.

A series of analytic techniques may be applied to the graphic and tabular type of presentation given. Listing of economic efficiency may be made with various cost and income data remaining constant while others vary in amount. Comparisons may also be made between projects and listing developed that show the best results in terms of quantity and quality of wood fiber produced per dollar of input cost.

The benefit/cost ratios expressed are opportunity costs in the sense that they represent an opportunity for an investment in an intensive management project. They are not "opportunity costs" in economic terms which may be defined as "..... the value of the best alternative use to which this capital can be put".

An analysis of the allowable cut alternatives developed under Steps 3 and 4 of the Unit Resource Analysis (URA) will show how much more

timber can be produced through intensive management than can be produced at the base zero (non-intensive) level of management for each of the silvicultural practices involved. The screening process can be used to determine the lower or marginal limit of site quality available for precommercial-thinning-only operations. Site availability is dependent principally upon biological response, initial project cost and a series of annual costs and returns.

Present Net Worth  
Benefit/Cost Ratio  
25 - 5 - (5-10-20-40-80)

Lodgepole Pine--Site Index 60

Precommercial Thin Only--At 20 Years of Age

Average stand volume--mature timber	20,000	Bd. Ft. acre
Increase in volume due to thinning	30,400	Bd. Ft. acre
Investment period	80	Years
Annual allowable cut increment increase	380	Bd. Ft.
Additional acreage cut and reforested <u>1/</u>	0.0190	Acres
Cost of reforestation @\$50.00 per acre <u>1/</u> *	\$0.95	Annually

\* Not included in following computations

Code	\$25	Cost to PCT one acre			
	5	Cost to sell one MBF of mature timber			
	5	Income from sale of one MBF of mature timber			
	B/C	Ratio @ 6%	=		0.57
		Present net worth @ 6%	=		\$-25.00

---

Code	\$25	Cost to PCT one acre			
	5	Cost to sell one MBF of mature timber			
	10	Income from sale of one MBF of mature timber			
	B/C	Ratio @ 6%	=		1.14
		Present net worth @ 6%	=		\$8.25

---

Code	\$25	Cost of PCT one acre			
	5	Cost to sell one MBF of mature timber			
	20	Income from sale of one MBF of mature timber			
	B/C	Ratio @ 6%	=		2.28
		Present net worth @ 6%	=		\$74.75

---

Code	\$25 <u>2/</u>	Cost to PCT one acre			
	5 "	Cost to sell one MBF of mature timber			
	40 "	Income from sale of one MBF of mature timber			
	B/C	Ratio @ 6%	=		4.57
		Present net worth @ 6%	=		\$207.75

---

Code	\$25 <u>2/</u>	Cost of PCT one acre			
	5 "	Cost to sell one MBF of mature timber			
	80 "	Income from sale of one MBF of mature timber			
	B/C	Ratio @ 6%	=		9.13
		Present net worth @ 6%	=		\$473.74

1/ Site Index 60 Lodgepole pine is generally clear-cut and can be regenerated naturally; therefore, no reforestation costs were included in the above B/C analysis. If you wish to include reforestation costs of \$50.00 per acre, note that this is equivalent to adding \$5.00 per MBF to the cost of selling timber.

2/ Plotted curve lies off of the B/C Ratio Graph (next page).

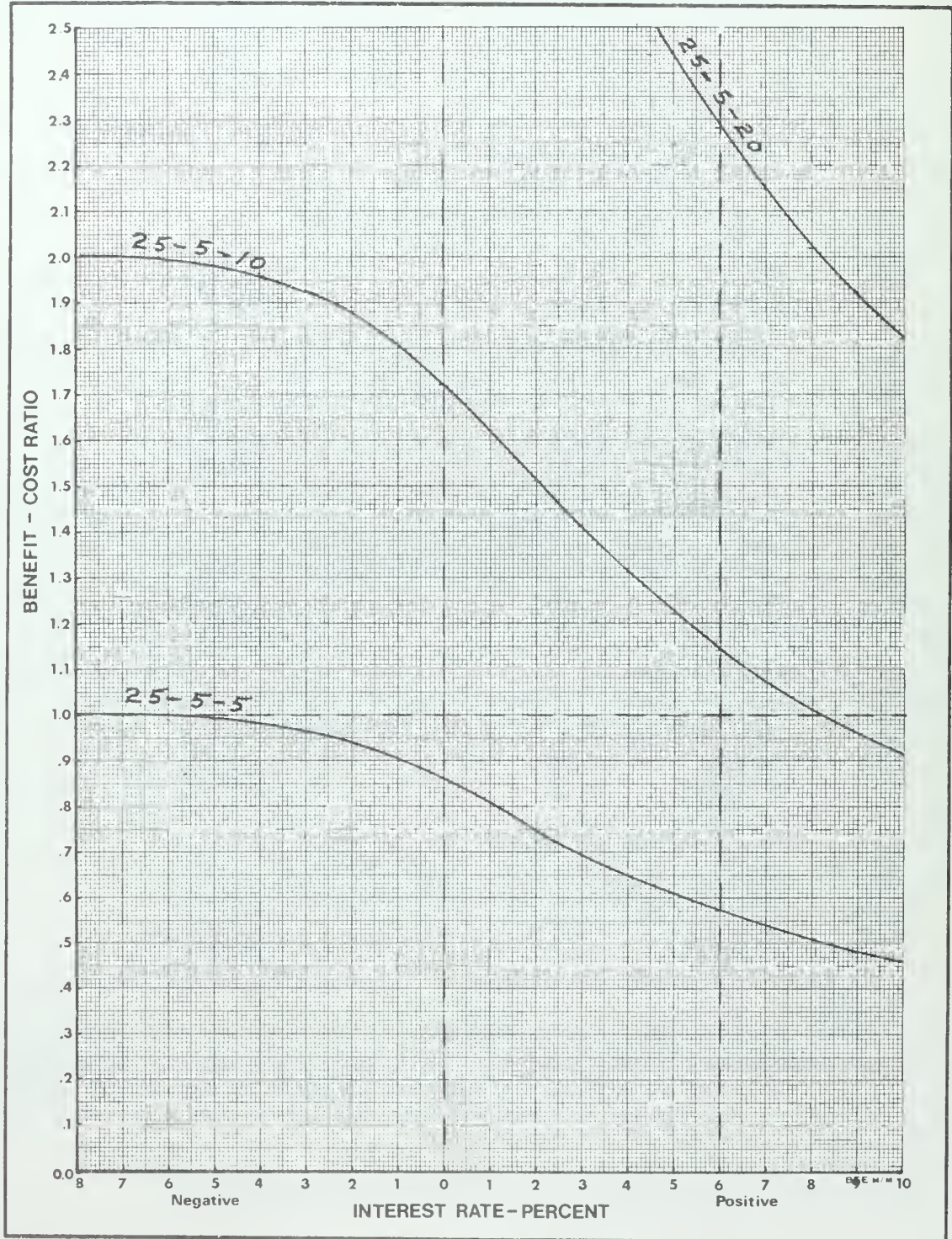
# BENEFIT/COST RATIO

## Alternatives

25-5-(5-10-20-40-80)

Lodgepole Pine--Site Index 60

Precommercial Thin Only--@ 20 Years of Age



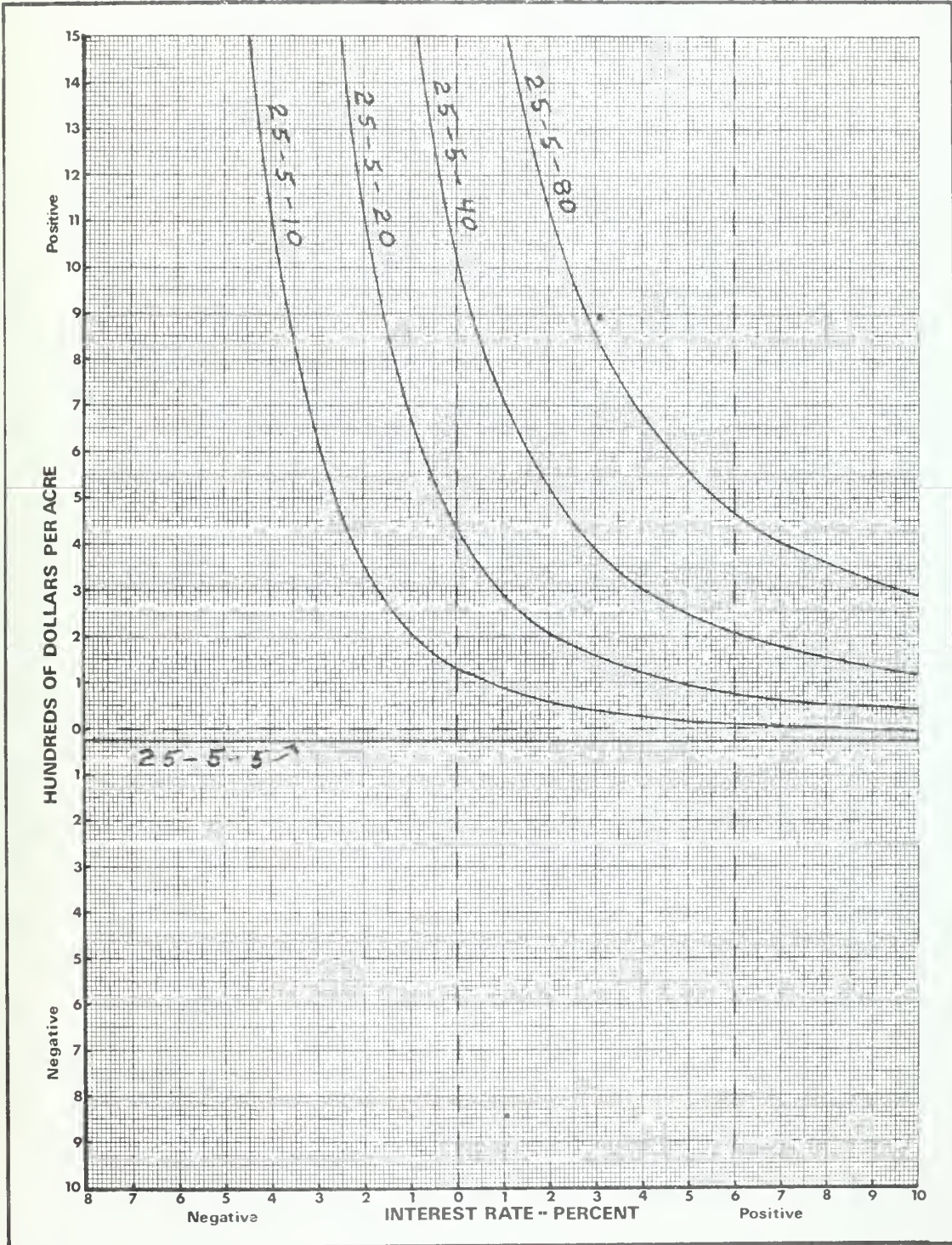
# PRESENT NET WORTH

## Alternatives

25-5-(5-10-20-40-80)

Lodgepole Pine--Site Index 60

Precommercial Thin Only--@ 20 Years of Age



BENEFIT-COST ANALYSIS--PRECOMMERCIAL THIN @ AGE 20 ONLY

PROBLEM NO. 1 LODGEPOLE PINE; SITE INDEX 60; FINAL HARVEST @ 100 YEARS; HORAK

BENEFIT-COST RATIO (B/C) AT ALTERNATIVE RATES OF INTEREST  
PRESENT NET WORTH (PNW) AT ALTERNATIVE RATES OF INTEREST

RATE	MANAGEMENT ALTERNATIVE									
	25-05-05		25-05-10		25-05-20		25-05-40		25-05-80	
	*PNW	B/C*	*PNW	B/C*	*PNW	B/C*	*PNW	B/C*	*PNW	B/C*
-10.00	-25.00	1.00	78227.90	2.00	234733.71	4.00	547745.33	8.00	1173768.56	15.99
-9.00	-25.00	1.00	36283.76	2.00	108901.27	4.00	254136.29	7.99	544606.34	15.99
-8.00	-25.00	1.00	17188.70	2.00	51616.11	3.99	120470.93	7.99	258160.56	15.98
-7.00	-25.00	1.00	8334.75	1.99	25054.25	3.99	58493.24	7.98	125371.23	15.95
-6.00	-25.00	0.99	4147.68	1.99	12493.03	3.98	29183.74	7.95	62565.16	15.90
-5.00	-25.00	0.99	2124.74	1.98	6424.23	3.95	15023.19	7.91	32221.13	15.82
-4.00	-25.00	0.96	1124.12	1.96	3422.36	3.91	8018.84	7.83	17211.80	15.66
-3.00	-25.00	0.96	616.10	1.92	1898.29	3.85	4462.68	7.70	9591.46	15.40
-2.00	-25.00	0.94	350.57	1.88	1101.70	3.75	2603.96	7.50	5608.49	15.00
-1.00	-25.00	0.90	207.21	1.81	671.64	3.61	1600.49	7.22	3458.20	14.44
0.00	-25.00	0.86	127.00	1.72	431.00	3.44	1039.00	6.87	2255.00	13.74
1.00	-25.00	0.81	80.33	1.62	290.99	3.23	712.31	6.47	1554.96	12.93
2.00	-25.00	0.75	52.02	1.51	206.07	3.02	514.17	6.04	1130.37	12.08
3.00	-25.00	0.70	34.10	1.41	152.31	2.81	388.72	5.62	861.54	11.24
4.00	-25.00	0.65	22.26	1.31	116.77	2.62	305.80	5.23	683.85	10.46
5.00	-25.00	0.61	14.09	1.22	92.28	2.44	248.66	4.88	561.42	9.76
6.00	-25.00	0.57	8.25	1.14	74.75	2.28	207.75	4.57	473.74	9.13
7.00	-25.00	0.54	3.91	1.07	61.74	2.15	177.39	4.29	408.70	8.58
8.00	-25.00	0.51	0.60	1.01	51.79	2.02	154.17	4.05	358.93	8.09
9.00	-25.00	0.48	-2.01	0.96	43.96	1.92	135.91	3.83	319.82	7.66
10.00	-25.00	0.46	-4.11	0.91	37.67	1.82	121.23	3.64	288.35	7.28
11.00	-25.00	0.43	-5.83	0.87	32.50	1.74	109.18	3.47	262.52	6.94
12.00	-25.00	0.41	-7.27	0.83	29.19	1.66	99.12	3.32	240.97	6.64
13.00	-25.00	0.40	-8.49	0.80	24.54	1.59	90.60	3.18	222.72	6.36
14.00	-25.00	0.38	-9.53	0.76	21.41	1.53	83.30	3.06	207.06	6.12
15.00	-25.00	0.37	-10.43	0.74	18.70	1.47	76.97	2.95	193.50	5.89

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Present Net Worth  
Benefit/Cost Ratio  
25 -10- (5-10-20-40-80)  
Lodgepole Pine--Site Index 60

Precommercial Thin Only--At 20 Years of Age

Average stand volume-mature timber	20,000	Bd. Ft. acre
Increase in volume due to thinning	30,400	Bd. Ft. acre
Investment period	80	Years
Annual allowable cut increment increase	380	Bd. Ft.
Additional acreage cut and reforested <u>1/</u>	0.019	Acres
Cost of reforestation @\$50.00 per acre <u>1/</u>	\$0.95	Annually

---

Code <u>\$25</u>	Cost to PCT one acre		
<u>10</u>	Cost to sell one MBF of mature timber		
<u>5</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio @ 6%	=	0.36
Present net worth	@ 6%	=	\$-58.25

---

Code <u>\$25</u>	Cost to PCT one acre		
<u>10</u>	Cost to sell one MBF of mature timber		
<u>10</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio @ 6%	=	0.73
Present net worth	@ 6%	=	\$-23.58

---

Code <u>\$25</u>	Cost of PCT one acre		
<u>10</u>	Cost to sell one MBF of mature timber		
<u>20</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio @ 6%	=	1.45
Present net worth	@ 6%	=	\$39.15

---

Code <u>\$25</u>	Cost to PCT one acre		
<u>10</u>	Cost to sell one MBF of mature timber		
<u>40</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio @ 6%	=	2.91
Present net worth	@ 6%	=	\$164.62

---

Code <u>\$25</u>	Cost of PCT one acre		
<u>10</u>	Cost to sell one MBF of mature timber		
<u>80</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio @ 6%	=	5.81
Present net worth	@ 6%	=	\$440.49

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1/ Site Index 60 Lodgepole pine is generally clear-cut and can be regenerated naturally; therefore, no reforestation costs were included in the above B/C analysis. If you wish to include reforestation costs of \$50.00 per acre, note that this is equivalent to adding \$5.00 per MBF to the cost of selling timber.



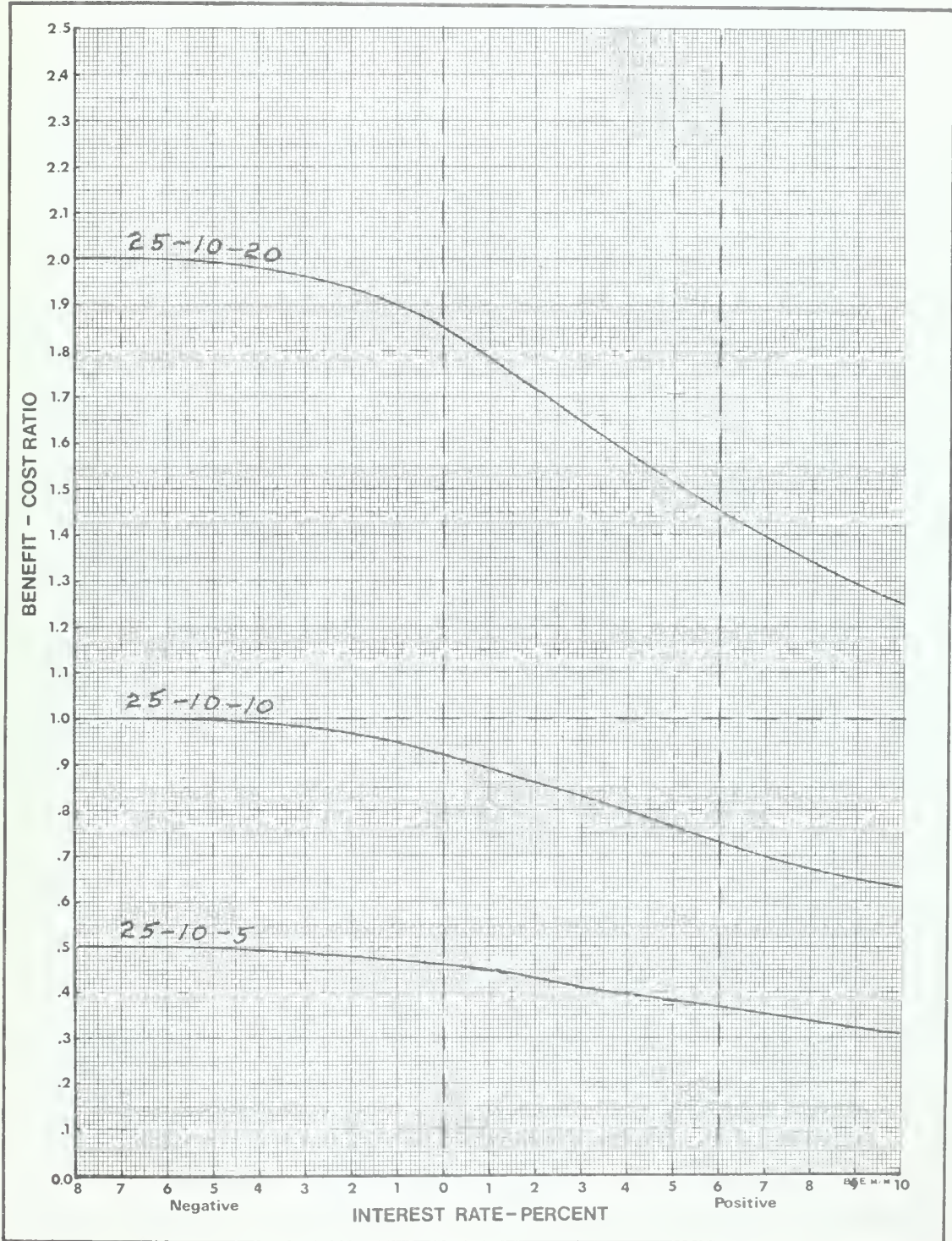
# BENEFIT/COST RATIO

## Alternatives

25-10-(5-10-20-40-80)

Lodgepole Pine--Site Index 60

Precommercial Thin--@ 20 Years of Age



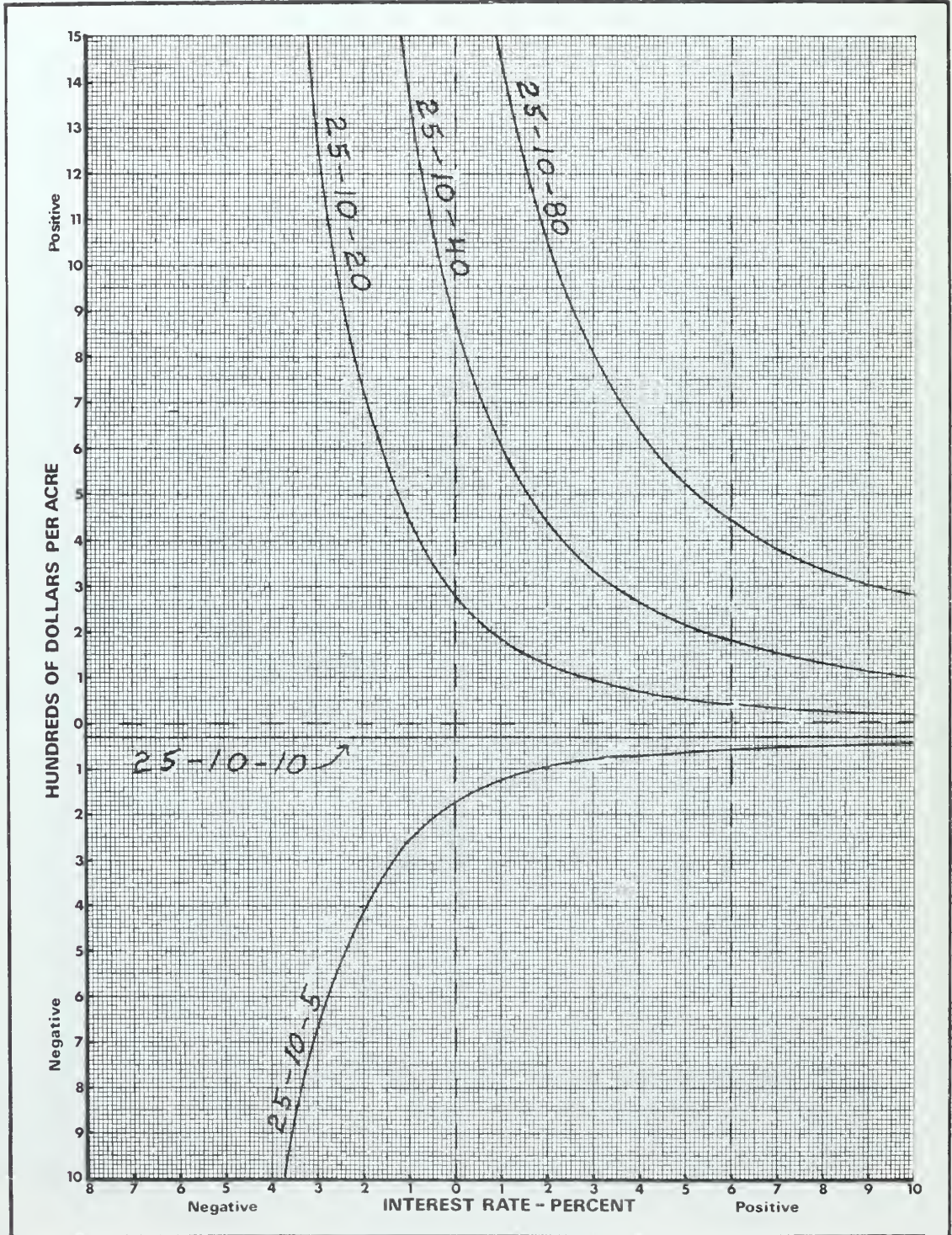
# PRESENT NET WORTH

## Alternatives

25-10-(5-10-20-40-80)

Lodgepole Pine--Site Index 60

Precommercial Thin Only--@ 20 Years of Age



BENEFIT-COST ANALYSIS--PRECOMMERCIAL THIN @ AGE 20 ONLY  
 PROBLEM NO. 1 LUDGEPOL PINE/ SITE INDEX 60/ FINAL HARVEST @ 100 YEARS/ HURAK

BENEFIT-COST RATIO (B/C) AT ALTERNATIVE RATES OF INTEREST  
 PRESENT NET WORTH (PNW) AT ALTERNATIVE RATES OF INTEREST

RATE	MANAGEMENT ALTERNATIVE									
	25-10-05	25-10-10	25-10-20	25-10-40	25-10-60	B/C*				
	*PNW	B/C*	*PNW	B/C*	*PNW	H/C*	*PNW	H/C*	*PNW	B/C*
-10.00	-78277.90	0.50	-25.00	1.00	15640.81	2.00	469492.42	4.00	1095515.65	8.00
-9.00	-36333.76	0.50	-25.00	1.00	72592.51	2.00	217627.54	4.00	508297.59	6.00
-8.00	-17238.70	0.50	-25.00	1.00	34402.41	2.00	103257.23	4.00	240766.86	7.99
-7.00	-8384.75	0.50	-25.00	1.00	16694.50	2.00	50133.49	3.99	117011.48	7.99
-6.00	-4197.68	0.50	-25.00	1.00	8320.35	1.99	25011.06	3.99	58392.44	7.99
-5.00	-2174.74	0.50	-25.00	0.99	4274.48	1.99	12873.45	3.98	30071.39	7.95
-4.00	-1174.12	0.49	-25.00	0.99	2273.74	1.98	6869.72	3.96	16062.08	7.91
-3.00	-666.10	0.49	-25.00	0.98	1257.19	1.96	3821.58	3.92	8950.36	7.85
-2.00	-400.57	0.44	-25.00	0.97	726.13	1.94	2228.40	3.87	5232.93	7.74
-1.00	-257.21	0.47	-25.00	0.95	439.43	1.90	1368.28	3.80	3225.99	7.59
0.00	-177.00	0.46	-25.00	0.92	279.00	1.85	887.00	3.70	2103.00	7.39
1.00	-130.33	0.45	-25.00	0.89	185.66	1.79	606.98	3.58	1449.63	7.15
2.00	-102.02	0.43	-25.00	0.86	129.05	1.72	437.15	3.44	1053.35	6.86
3.00	-84.10	0.41	-25.00	0.83	93.21	1.65	329.62	3.30	802.44	6.60
4.00	-72.26	0.40	-25.00	0.79	69.53	1.58	258.54	3.16	636.60	6.33
5.00	-64.09	0.38	-25.00	0.76	53.19	1.52	209.57	3.03	522.33	6.05
6.00	-58.25	0.36	-25.00	0.73	41.50	1.45	174.50	2.91	440.49	5.81
7.00	-53.91	0.35	-25.00	0.70	32.83	1.40	148.48	2.79	379.79	5.59
8.00	-50.60	0.34	-25.00	0.67	26.19	1.34	128.57	2.69	333.34	5.34
9.00	-47.99	0.32	-25.00	0.65	20.98	1.30	112.93	2.59	296.83	5.15
10.00	-45.89	0.31	-25.00	0.63	16.78	1.25	100.34	2.50	267.46	5.01
11.00	-44.17	0.30	-25.00	0.61	13.34	1.21	90.01	2.42	243.35	4.84
12.00	-42.73	0.29	-25.00	0.59	10.46	1.17	81.39	2.35	223.24	4.69
13.00	-41.51	0.28	-25.00	0.57	8.03	1.14	74.09	2.28	206.20	4.55
14.00	-40.47	0.28	-25.00	0.55	5.94	1.11	67.83	2.21	191.59	4.42
15.00	-39.57	0.27	-25.00	0.54	4.13	1.08	62.40	2.15	178.93	4.31

Present Net Worth  
Benefit/Cost Ratio  
25 - 15 (5-10-20-40-80)

Lodgepole Pine--Site Index 60

Precommercial Thin Only--At 20 Years of Age

Average stand volume-mature timber	20,000	Bd. Ft. acre
Increase in volume due to thinning	30,400	Bd. Ft. acre
Investment period	80	Years
Annual allowable cut increment increase	380	Bd. Ft.
Additional acreage cut and reforested <u>1/</u>	0.019	Acres
Cost of reforestation @\$50.00 per acre <u>1/</u>	\$0.95	Annually

Code	<u>\$25</u>	Cost to PCT one acre		
	<u>15</u>	Cost to sell one MBF of mature timber		
	<u>5</u>	Income from sale of one MBF of mature timber		
	<u>B/C</u>	Ratio @ <u>6%</u>	=	0.27
		Present net worth @ <u>6%</u>	=	<u>\$-91.50</u>

Code	<u>\$25</u>	Cost to PCT one acre		
	<u>15</u>	Cost to sell one MBF of mature timber		
	<u>10</u>	Income from sale of one MBF of mature timber		
	<u>B/C</u>	Ratio @ <u>6%</u>	=	0.53
		Present net worth @ <u>6%</u>	=	<u>\$-58.25</u>

Code	<u>\$25</u>	Cost of PCT one acre		
	<u>15</u>	Cost to sell one MBF of mature timber		
	<u>20</u>	Income from sale of one MBF of mature timber		
	<u>B/C</u>	Ratio @ <u>6%</u>	=	1.07
		Present net worth @ <u>6%</u>	=	<u>\$8.25</u>

Code	<u>\$25</u>	Cost to PCT one acre		
	<u>15</u>	Cost to sell one MBF of mature timber		
	<u>40</u>	Income from sale of one MBF of mature timber		
	<u>B/C</u>	Ratio @ <u>6%</u>	=	2.13
		Present net worth @ <u>6%</u>	=	<u>\$141.25</u>

Code	<u>\$25</u>	Cost of PCT one acre		
	<u>15</u>	Cost to sell one MBF of mature timber		
	<u>80</u>	Income from sale of one MBF of mature timber		
	<u>B/C</u>	Ratio @ <u>6%</u>	=	4.26
		Present net worth @ <u>6%</u>	=	<u>\$407.24</u>

1/ Site Index 60 Lodgepole pine is generally clear-cut and can be regenerated naturally; therefore, no reforestation costs were included in the above B/C analysis. If you wish to include reforestation costs of \$50.00 per acre, note that this is equivalent to adding \$5.00 per MBF to the cost of selling timber.

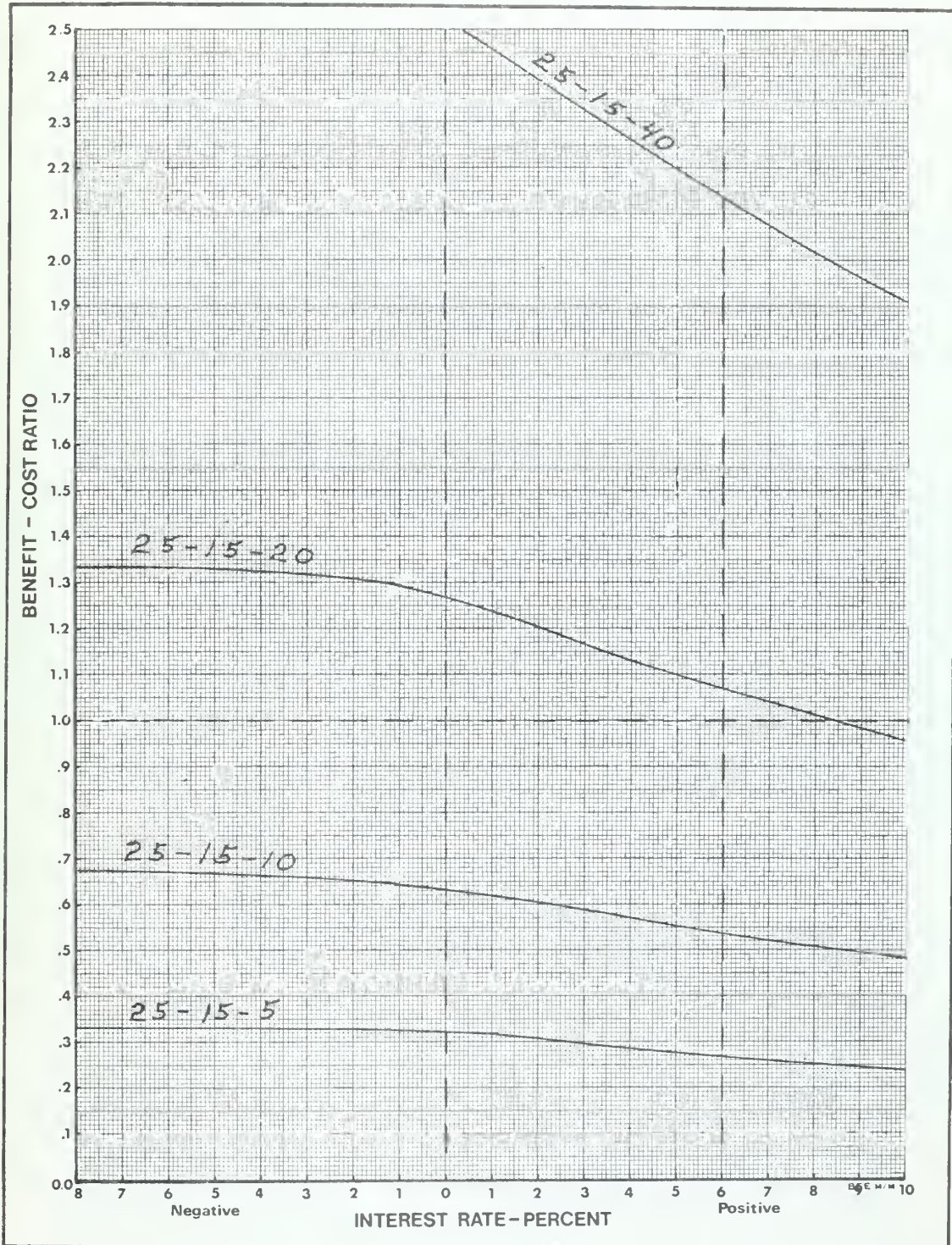
# BENEFIT/COST RATIO

## Alternatives

25-15-(5-10-20-40-80)

Lodgepole Pine--Site Index 60

Precommercial Thin Only--@ 20 Years of Age



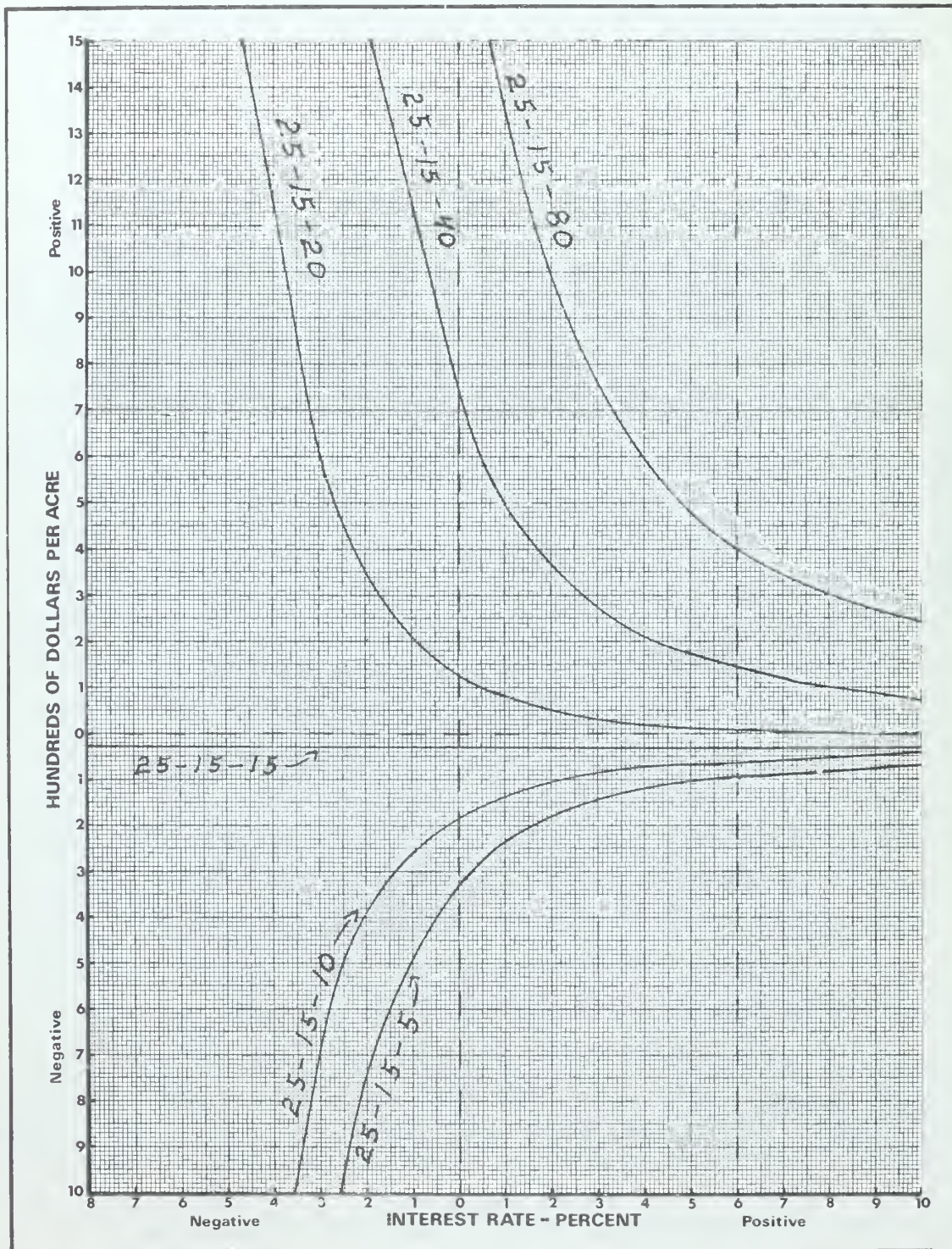
# PRESENT NET WORTH

## Alternatives

25-15-(5-10-20-40-80)

Lodgepole Pine--Site Index 60

Precommercial Thin Only--@ 20 Years of Age



BENEFIT-COST ANALYSIS--PRELIMINARY @ AGE 20 ONLY

PROBLEM NO. 1 LUDGEPole PINEJ SITE INDEX 60; FINAL HARVEST @ 100 YEARS; HORAK

BENEFIT-COST RATIO (B/C) AT ALTERNATIVE RATES OF INTEREST  
PRESENT NET WORTH (PNW) AT ALTERNATIVE RATES OF INTEREST

RATE	25-15-05			25-15-10			25-15-20			25-15-40			25-15-80		
	*PNW	B/C*	B/C*	*PNW	B/C*	B/C*	*PNW	B/C*	B/C*	*PNW	B/C*	B/C*	*PNW	B/C*	B/C*
-10.00	-156530.81	0.33	0.67	-78277.90	0.67	1.33	78227.90	1.33	391239.52	2.67	1017262.75	5.33	5.33	5.33	5.33
-9.00	-72642.51	0.33	0.67	-36333.76	0.67	1.33	36283.76	1.33	181518.78	2.67	471988.83	5.33	5.33	5.33	5.33
-8.00	-34452.41	0.33	0.67	-17238.70	0.67	1.33	17188.70	1.33	86043.52	2.67	223753.16	5.33	5.33	5.33	5.33
-7.00	-16744.50	0.33	0.67	-8384.75	0.67	1.33	8334.75	1.33	41773.74	2.66	108651.73	5.33	5.33	5.33	5.33
-6.00	-8370.35	0.33	0.67	-4197.68	0.67	1.33	4147.68	1.33	20838.39	2.66	54219.80	5.33	5.33	5.33	5.33
-5.00	-4324.48	0.33	0.66	-2174.74	0.66	1.33	2124.74	1.33	10723.71	2.65	27921.65	5.31	5.31	5.31	5.31
-4.00	-2323.24	0.33	0.66	-1174.12	0.66	1.32	1124.12	1.32	5720.80	2.65	14913.56	5.29	5.29	5.29	5.29
-3.00	-1307.19	0.33	0.66	-666.10	0.66	1.32	616.10	1.32	3180.49	2.63	8309.27	5.26	5.26	5.26	5.26
-2.00	-776.13	0.33	0.65	-400.57	0.65	1.30	350.57	1.30	1852.83	2.61	4857.36	5.22	5.22	5.22	5.22
-1.00	-489.43	0.32	0.64	-257.21	0.64	1.29	207.21	1.29	1136.07	2.57	2993.77	5.15	5.15	5.15	5.15
0.00	-329.00	0.32	0.63	-177.00	0.63	1.26	127.00	1.26	735.00	2.53	1951.00	5.06	5.06	5.06	5.06
1.00	-235.66	0.31	0.62	-130.33	0.62	1.24	80.33	1.24	501.65	2.47	1344.80	4.94	4.94	4.94	4.94
2.00	-179.05	0.30	0.60	-102.02	0.60	1.20	52.02	1.20	360.12	2.41	976.32	4.81	4.81	4.81	4.81
3.00	-143.21	0.29	0.58	-84.10	0.58	1.17	34.10	1.17	270.51	2.34	743.34	4.67	4.67	4.67	4.67
4.00	-119.51	0.28	0.57	-72.26	0.57	1.13	22.26	1.13	211.28	2.27	589.34	4.53	4.53	4.53	4.53
5.00	-103.19	0.27	0.55	-64.09	0.55	1.10	14.09	1.10	170.47	2.20	483.23	4.40	4.40	4.40	4.40
6.00	-91.50	0.27	0.53	-58.25	0.53	1.07	8.25	1.07	141.25	2.13	407.24	4.26	4.26	4.26	4.26
7.00	-82.83	0.26	0.52	-53.91	0.52	1.04	3.91	1.04	119.57	2.07	350.87	4.14	4.14	4.14	4.14
8.00	-76.19	0.25	0.50	-50.60	0.50	1.01	0.60	1.01	102.98	2.01	307.74	4.02	4.02	4.02	4.02
9.00	-70.98	0.24	0.49	-47.99	0.49	0.98	-2.01	0.98	89.94	1.96	273.84	3.91	3.91	3.91	3.91
10.00	-66.78	0.24	0.48	-45.89	0.48	0.95	-4.11	0.95	79.45	1.91	246.57	3.81	3.81	3.81	3.81
11.00	-63.34	0.23	0.46	-44.17	0.46	0.93	-5.83	0.93	70.84	1.86	224.19	3.72	3.72	3.72	3.72
12.00	-60.46	0.23	0.45	-42.73	0.45	0.91	-7.27	0.91	63.66	1.81	205.51	3.63	3.63	3.63	3.63
13.00	-58.03	0.22	0.44	-41.51	0.44	0.89	-8.49	0.89	57.57	1.77	189.69	3.54	3.54	3.54	3.54
14.00	-55.94	0.22	0.43	-40.47	0.43	0.87	-9.53	0.87	52.35	1.73	176.12	3.47	3.47	3.47	3.47
15.00	-54.13	0.21	0.42	-39.57	0.42	0.85	-10.43	0.85	47.83	1.70	164.36	3.39	3.39	3.39	3.39

Present Net Worth  
Benefit/Cost Ratio  
50 - 5 - (5-10-20-40-80)  
Lodgepole Pine--Site Index 60

Precommercial Thin Only--At 20 Years of Age

Average stand volume-mature timber	20,000	Bd. Ft. acre
Increase in volume due to thinning	<u>30,400</u>	Bd. Ft. acre
Investment period	<u>80</u>	Years
Annual allowable cut increment increase	<u>380</u>	Bd. Ft.
Additional acreage cut and reforested <u>1/</u>	<u>0.019</u>	Acres
Cost of reforestation @\$50.00 per acre <u>1/</u>	<u>\$0.95</u>	Annually

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Code <u>\$50</u>	Cost to PCT one acre		
<u>5</u>	Cost to sell one MBF of mature timber		
<u>5</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio @ <u>6%</u>	=	<u>0.40</u>
Present net worth	@ <u>6%</u>	=	<u>\$-50.00</u>

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Code <u>\$50</u>	Cost to PCT one acre		
<u>5</u>	Cost to sell one MBF of mature timber		
<u>10</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio @ <u>6%</u>	=	<u>0.80</u>
Present net worth	@ <u>6%</u>	=	<u>\$-16.75</u>

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Code <u>\$50</u>	Cost of PCT one acre		
<u>5</u>	Cost to sell one MBF of mature timber		
<u>20</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio @ <u>6%</u>	=	<u>1.60</u>
Present net worth	@ <u>6%</u>	=	<u>\$46.93</u>

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Code <u>\$50</u>	Cost to PCT one acre		
<u>5</u>	Cost to sell one MBF of mature timber		
<u>40</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio @ <u>6%</u>	=	<u>3.20</u>
Present net worth	@ <u>6%</u>	=	<u>\$182.40</u>

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Code <u>\$50</u>	Cost of PCT one acre		
<u>5</u>	Cost to sell one MBF of mature timber		
<u>80</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio @ <u>6%</u>	=	<u>6.39</u>
Present net worth	@ <u>6%</u>	=	<u>\$448.74</u>

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1/ Site Index 60 Lodgepole pine is generally clear-cut and can be regenerated naturally; therefore, no reforestation costs were included in the above B/C analysis. If you wish to include reforestation costs of \$50.00 per acre, note that this is equivalent to adding \$5.00 per MBF to the cost of selling timber.



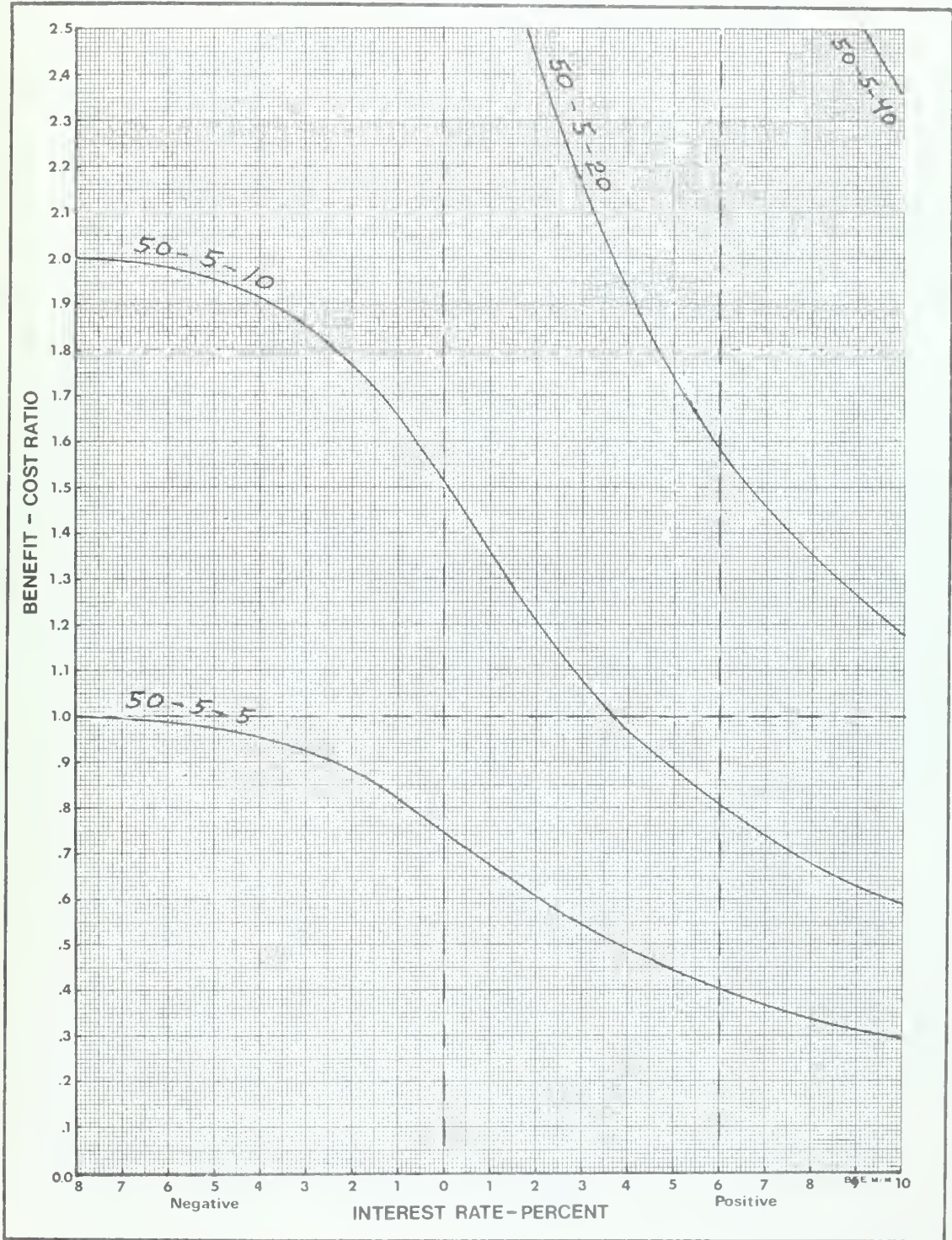
# BENEFIT/COST RATIO

## Alternatives

50-5-(5-10-20-40-80)

Lodgepole Pine--Site Index 60

Precommercial Thin Only--@ 20 Years of Age



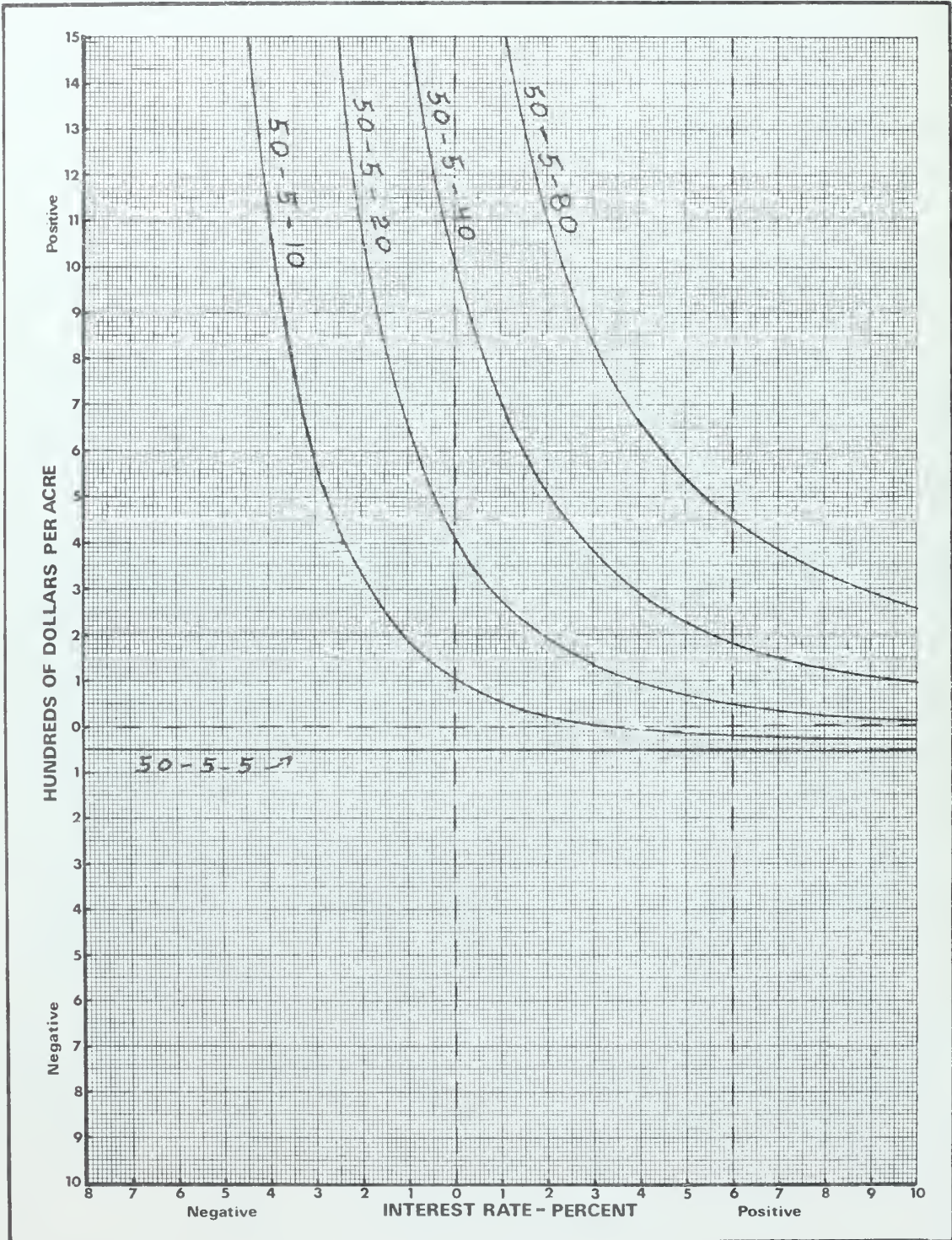
# PRESENT NET WORTH

## Alternatives

50-5-(5-10-20-40-80)

Lodgepole Pine--Site Index 60

Precommercial Thin Only--@ 20 Years of Age



BENEFIT-COST ANALYSIS--PRECOMMERCIAL THIN @ AGE 20 ONLY

PROBLEM NO. 2 LODGEPOLE PINE/ SITE INDEX 60/ FINAL HARVEST @ 100 YEARS/ HORAK

BENEFIT-COST RATIO (B/C) AT ALTERNATIVE RATES OF INTEREST  
PRESENT NET WORTH (PNW) AT ALTERNATIVE RATES OF INTEREST

RATE	50-05-05			50-05-10			50-05-20			50-05-40			50-05-80		
	*PNW	B/C*	*PNW	B/C*	*PNW	B/C*	*PNW	B/C*	*PNW	B/C*	*PNW	B/C*	*PNW	B/C*	
-10.00	-50.00	1.00	78202.90	2.00	234708.71	4.00	547720.33	7.99	1173743.56	15.99					
-9.00	-50.00	1.00	36258.76	2.00	108876.27	3.99	254111.29	7.99	544581.34	15.98					
-8.00	-50.00	1.00	17163.70	1.99	51591.11	3.99	120445.93	7.98	258155.56	15.95					
-7.00	-50.00	0.99	8309.75	1.99	25029.25	3.98	58468.24	7.95	129346.23	15.90					
-6.00	-50.00	0.99	4122.68	1.98	12468.03	3.95	29158.74	7.91	62540.16	15.81					
-5.00	-50.00	0.98	2099.74	1.95	6399.23	3.91	14998.19	7.82	32196.13	15.64					
-4.00	-50.00	0.96	1099.12	1.92	3397.36	3.83	7993.84	7.67	17186.80	15.33					
-3.00	-50.00	0.93	591.10	1.86	1873.29	3.71	4437.08	7.42	9566.46	14.84					
-2.00	-50.00	0.88	375.57	1.77	1076.70	3.53	2578.96	7.06	5583.49	14.12					
-1.00	-50.00	0.82	182.21	1.65	646.64	3.29	1575.49	6.58	3433.20	13.17					
0.00	-50.00	0.75	102.00	1.50	406.00	3.01	1014.00	6.02	2230.00	12.04					
1.00	-50.00	0.68	55.33	1.36	265.99	2.71	687.31	5.42	1529.96	10.85					
2.00	-50.00	0.61	27.02	1.21	181.07	2.43	485.17	4.85	1105.37	9.70					
3.00	-50.00	0.54	9.10	1.08	127.31	2.17	363.72	4.33	836.54	8.67					
4.00	-50.00	0.49	-2.74	0.97	91.77	1.94	280.80	3.89	658.85	7.77					
5.00	-50.00	0.44	-10.91	0.88	67.28	1.76	223.66	3.51	536.42	7.02					
6.00	-50.00	0.40	-16.75	0.80	49.75	1.60	182.75	3.20	448.74	6.39					
7.00	-50.00	0.37	-21.09	0.73	36.74	1.47	152.39	2.93	383.70	5.86					
8.00	-50.00	0.34	-24.40	0.68	26.79	1.35	129.17	2.71	333.93	5.42					
9.00	-50.00	0.31	-27.01	0.63	18.96	1.26	110.91	2.52	294.82	5.04					
10.00	-50.00	0.29	-29.11	0.59	12.67	1.18	96.23	2.36	263.35	4.71					
11.00	-50.00	0.28	-30.83	0.55	7.50	1.11	84.18	2.22	237.52	4.43					
12.00	-50.00	0.26	-32.27	0.52	3.19	1.05	74.12	2.09	215.97	4.19					
13.00	-50.00	0.25	-33.49	0.50	-0.46	0.99	65.60	1.99	197.72	3.97					
14.00	-50.00	0.24	-34.53	0.47	-3.59	0.95	58.30	1.89	182.06	3.78					
15.00	-50.00	0.23	-35.43	0.45	-6.30	0.90	51.97	1.80	168.50	3.61					

Present Net Worth  
Benefit/Cost Ratio  
50-10-(5-10-20-40-80)  
Lodgepole Pine--Site Index 60

Precommercial Thin Only--At 20 Years of Age

Average stand volume-mature timber	20,000	Bd. Ft. acre
Increase in volume due to thinning	30,400	Bd. Ft. acre
Investment period	80	Years
Annual allowable cut increment increase	380	Bd. Ft.
Additional acreage cut and reforested <u>1/</u>	0.019	Acres
Cost of reforestation @\$50.00 per acre <u>1/</u>	\$0.95	Annually

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Code <u>\$50</u>	Cost to PCT one acre		
<u>10</u>	Cost to sell one MBF of mature timber		
<u>5</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio @ <u>6%</u>	=	<u>0.29</u>
Present net worth	@ <u>6%</u>	=	<u>\$-83.25</u>

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Code <u>\$50</u>	Cost to PCT one acre		
<u>10</u>	Cost to sell one MBF of mature timber		
<u>10</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio @ <u>6%</u>	=	<u>0.57</u>
Present net worth	@ <u>6%</u>	=	<u>\$- 50.00</u>

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Code <u>\$50</u>	Cost of PCT one acre		
<u>10</u>	Cost to sell one MBF of mature timber		
<u>20</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio @ <u>6%</u>	=	<u>1.14</u>
Present net worth	@ <u>6%</u>	=	<u>\$16.50</u>

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Code <u>\$50</u>	Cost to PCT one acre		
<u>10</u>	Cost to sell one MBF of mature timber		
<u>40</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio @ <u>6%</u>	=	<u>2.28</u>
Present net worth	@ <u>6%</u>	=	<u>\$ 149.50</u>

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Code <u>\$50</u>	Cost of PCT one acre		
<u>10</u>	Cost to sell one MBF of mature timber		
<u>80</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio @ <u>6%</u>	=	<u>4.57</u>
Present net worth	@ <u>6%</u>	=	<u>\$415.49</u>

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1/ Site Index 60 Lodgepole pine is generally clear-cut and can be regenerated naturally; therefore, no reforestation costs were included in the above B/C analysis. If you wish to include reforestation costs of \$50.00 per acre, note that this is equivalent to adding \$5.00 per MBF to the cost of selling timber.

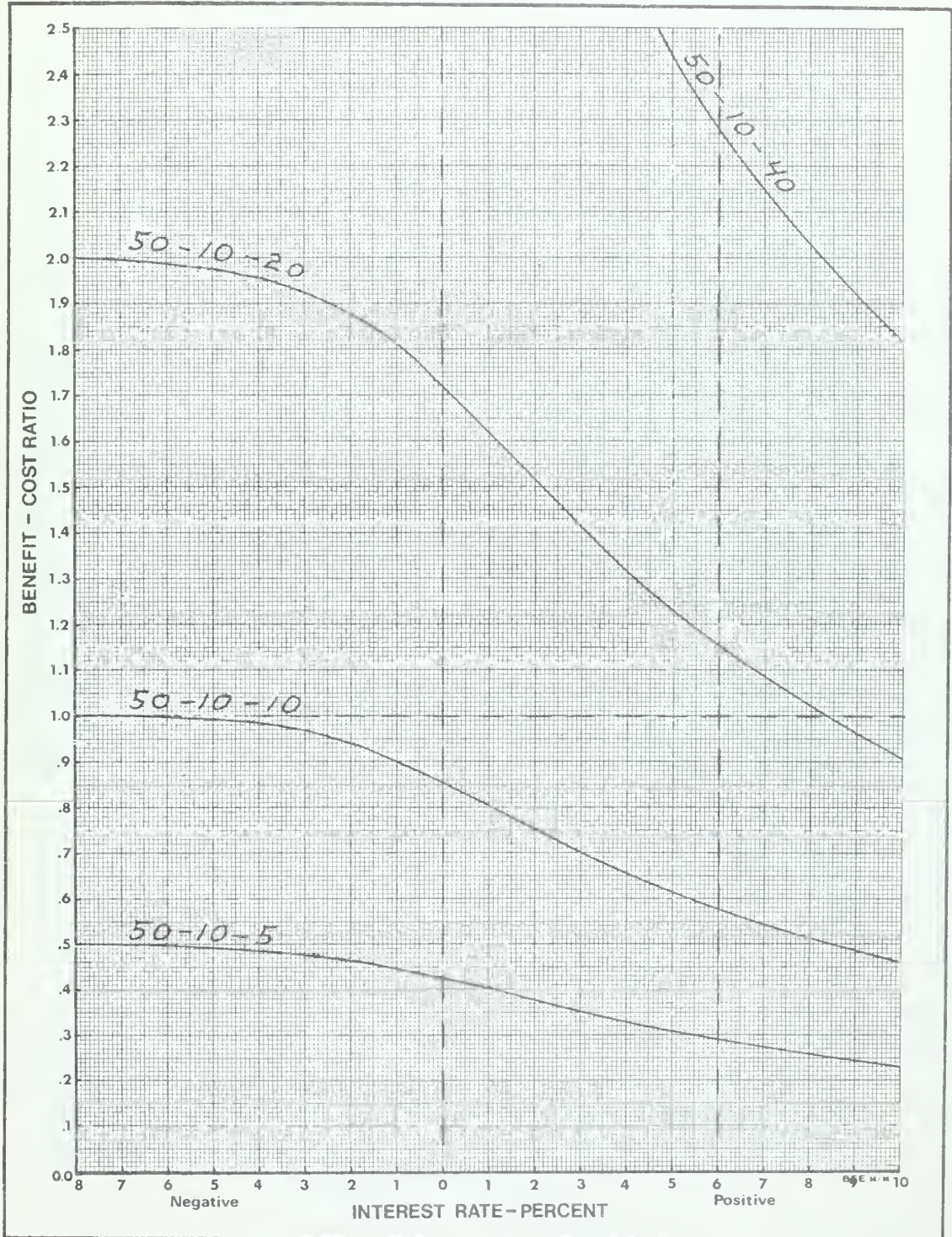
# BENEFIT/COST RATIO

## Alternatives

50-10-(5-10-20-40-80)

Lodgepole Pine--Site Index 60

Precommercial Thin Only--@ 20 Years of Age



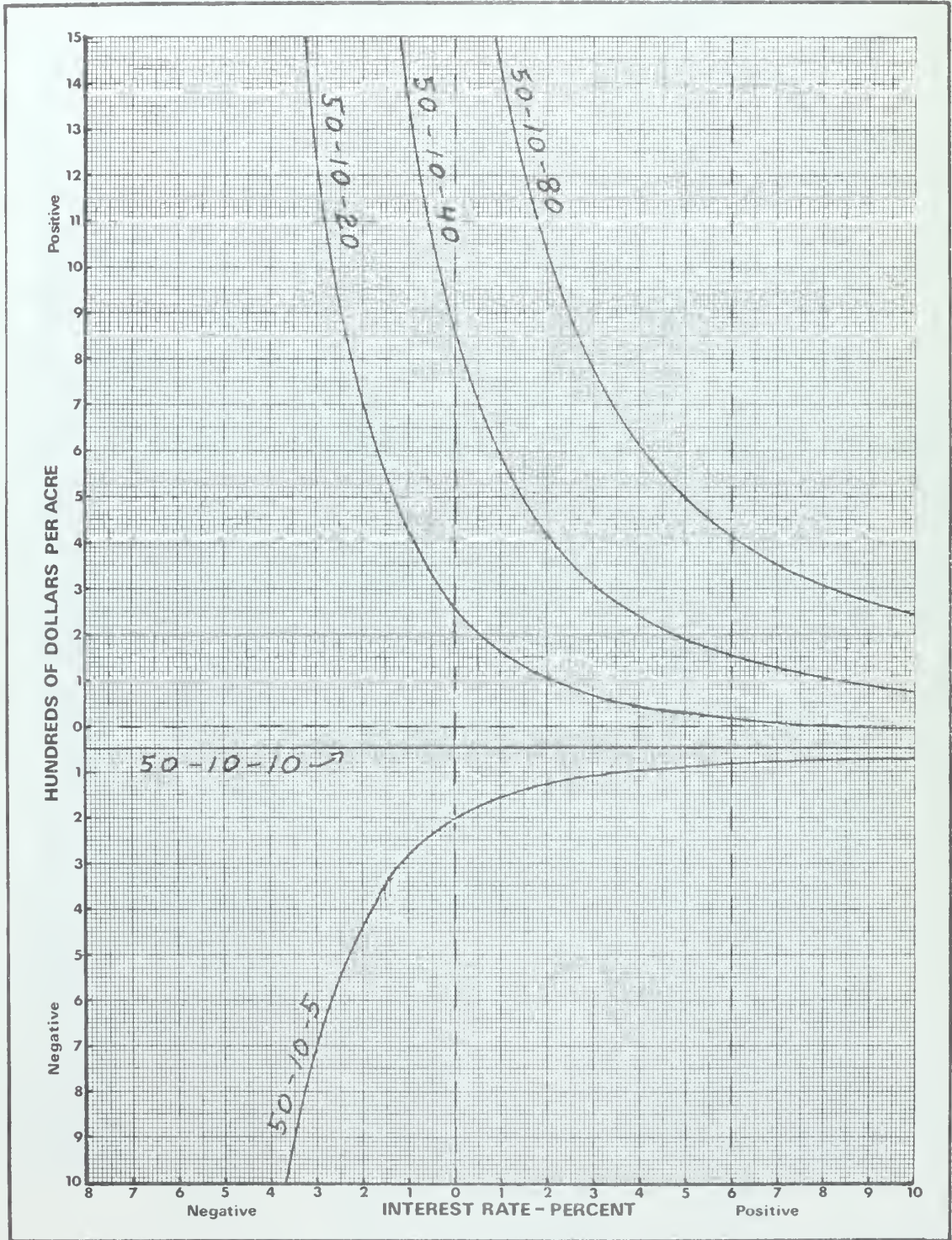
# PRESENT NET WORTH

## Alternatives

50-10-(5-10-20-40-80)

Lodgepole Pine--Site Index 60

Precommercial Thin Only--@ 20 Years of Age



BELEFIT-COST ANALYSIS--PRECOMMERCIAL THIN @ AGE 20 ONLY  
 LOGEPOLE PINE; SITE INDEX 60; FINAL HARVEST @ 100 YEARS; HURAK

BELEFIT-COST RATIO (B/C) AT ALTERNATIVE RATES OF INTEREST  
 PRESENT NET WORTH (PNW) AT ALTERNATIVE RATES OF INTEREST

RATE	MANAGEMENT ALTERNATIVE									
	50-10-05		50-10-10		50-10-20		50-10-40		50-10-80	
	*PNW	H/C*	*PNW	H/C*	*PNW	H/C*	*PNW	H/C*	*PNW	H/C*
10.00	-78302.90	0.50	-50.00	1.00	156455.81	2.00	469467.42	4.00	1095490.65	7.00
9.00	-3635.76	0.50	-50.00	1.00	72567.51	2.00	217802.54	4.00	508272.59	7.00
8.00	-17263.70	0.50	-50.00	1.00	34377.41	2.00	103232.23	3.99	240941.86	7.00
7.00	-849.75	0.50	-50.00	1.00	16669.50	1.99	50108.49	3.99	116940.44	7.00
6.00	-4222.64	0.50	-50.00	0.99	8295.35	1.99	24986.06	3.98	58367.48	7.00
5.00	-2199.74	0.49	-50.00	0.99	4249.48	1.98	12848.45	3.95	30046.39	7.00
4.00	-1199.12	0.49	-50.00	0.98	2244.24	1.96	6844.72	3.91	16037.68	7.00
3.00	-641.10	0.48	-50.00	0.96	1239.19	1.92	3796.58	3.85	8925.36	7.00
2.00	-425.57	0.47	-50.00	0.94	701.13	1.88	2203.40	3.75	5207.93	7.00
1.00	-272.21	0.45	-50.00	0.90	414.43	1.81	1343.28	3.61	3200.99	7.00
0.00	-202.00	0.43	-50.00	0.86	254.00	1.72	862.00	3.44	2078.00	6.57
1.00	-195.33	0.40	-50.00	0.81	150.66	1.62	581.98	3.23	1424.63	6.07
2.00	-177.02	0.38	-50.00	0.75	104.05	1.51	412.15	3.02	1028.35	6.04
3.00	-109.10	0.35	-50.00	0.70	68.21	1.41	304.62	2.81	777.44	5.62
4.00	-97.26	0.33	-50.00	0.65	44.51	1.31	233.54	2.62	611.60	5.23
5.00	-89.09	0.30	-50.00	0.61	28.19	1.22	184.57	2.44	497.33	4.84
6.00	-83.25	0.29	-50.00	0.57	16.50	1.14	149.50	2.28	415.49	4.57
7.00	-78.91	0.27	-50.00	0.54	7.83	1.07	123.46	2.15	354.79	4.29
8.00	-75.60	0.25	-50.00	0.51	1.19	1.01	103.57	2.02	308.34	4.05
9.00	-72.99	0.24	-50.00	0.48	-4.02	0.96	87.93	1.92	271.83	3.83
10.00	-70.89	0.23	-50.00	0.46	-8.22	0.91	75.34	1.82	242.46	3.64
11.00	-69.17	0.22	-50.00	0.43	-11.66	0.87	65.01	1.74	218.35	3.47
12.00	-67.73	0.21	-50.00	0.41	-14.54	0.83	56.39	1.66	198.24	3.32
13.00	-66.51	0.20	-50.00	0.40	-16.97	0.80	49.09	1.59	181.20	3.18
14.00	-65.47	0.19	-50.00	0.38	-19.06	0.76	42.83	1.53	166.59	3.06
15.00	-64.57	0.18	-50.00	0.37	-20.87	0.74	37.40	1.47	153.93	2.95

Present Net Worth  
Benefit/Cost Ratio  
50-15-(5-10-20-40-80)  
Lodgepole Pine--Site Index 60  
Precommercial Thin Only--At 20 Years of Age

Average stand volume-mature timber	<u>20,000</u>	Bd. Ft. acre
Increase in volume due to thinning	<u>30,400</u>	Bd. Ft. acre
Investment period	<u>80</u>	Years
Annual allowable cut increment increase	<u>380</u>	Bd. Ft.
Additional acreage cut and reforested <u>1/</u>	<u>0.019</u>	Acres
Cost of reforestation @\$50.00 per acre <u>1/</u>	<u>\$0.95</u>	Annually

Code <u>\$50</u>	Cost to PCT one acre		
<u>15</u>	Cost to sell one MBF of mature timber		
<u>5</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio @ <u>6%</u>	=	<u>0.22</u>
Present net worth	@ <u>6%</u>	=	<u>\$-116.50</u>

Code <u>\$50</u>	Cost to PCT one acre		
<u>15</u>	Cost to sell one MBF of mature timber		
<u>10</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio @ <u>6%</u>	=	<u>0.44</u>
Present net worth	@ <u>6%</u>	=	<u>\$-83.25</u>

Code <u>\$50</u>	Cost of PCT one acre		
<u>15</u>	Cost to sell one MBF of mature timber		
<u>20</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio @ <u>6%</u>	=	<u>0.89</u>
Present net worth	@ <u>6%</u>	=	<u>\$-16.75</u>

Code <u>\$50</u>	Cost to PCT one acre		
<u>15</u>	Cost to sell one MBF of mature timber		
<u>40</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio @ <u>6%</u>	=	<u>1.78</u>
Present net worth	@ <u>6%</u>	=	<u>\$116.25</u>

Code <u>\$50</u>	Cost of PCT one acre		
<u>15</u>	Cost to sell one MBF of mature timber		
<u>80</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio @ <u>6%</u>	=	<u>3.55</u>
Present net worth	@ <u>6%</u>	=	<u>\$382.24</u>

1/ Site Index 60 Lodgepole pine is generally clear-cut and can be regenerated naturally; therefore, no reforestation costs were included in the above B/C analysis. If you wish to include reforestation costs of \$50.00 per acre, note that this is equivalent to adding \$5.00 per MBF to the cost of selling timber.



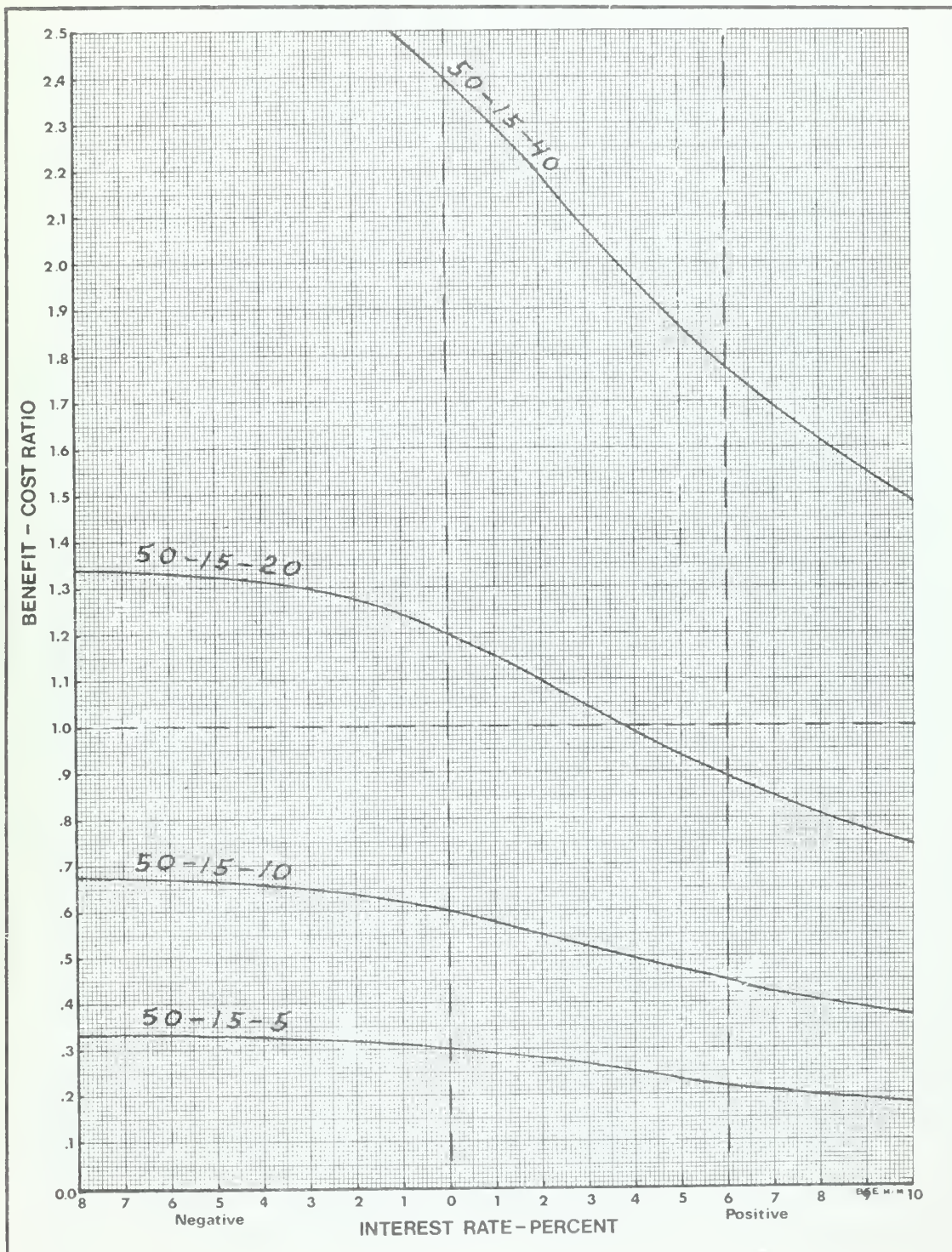
# BENEFIT/COST RATIO

## Alternatives

50-15-(5-10-20-40-80)

Lodgepole Pine--Site Index 60

Precommercial Thin Only--@ 20 Years of Age



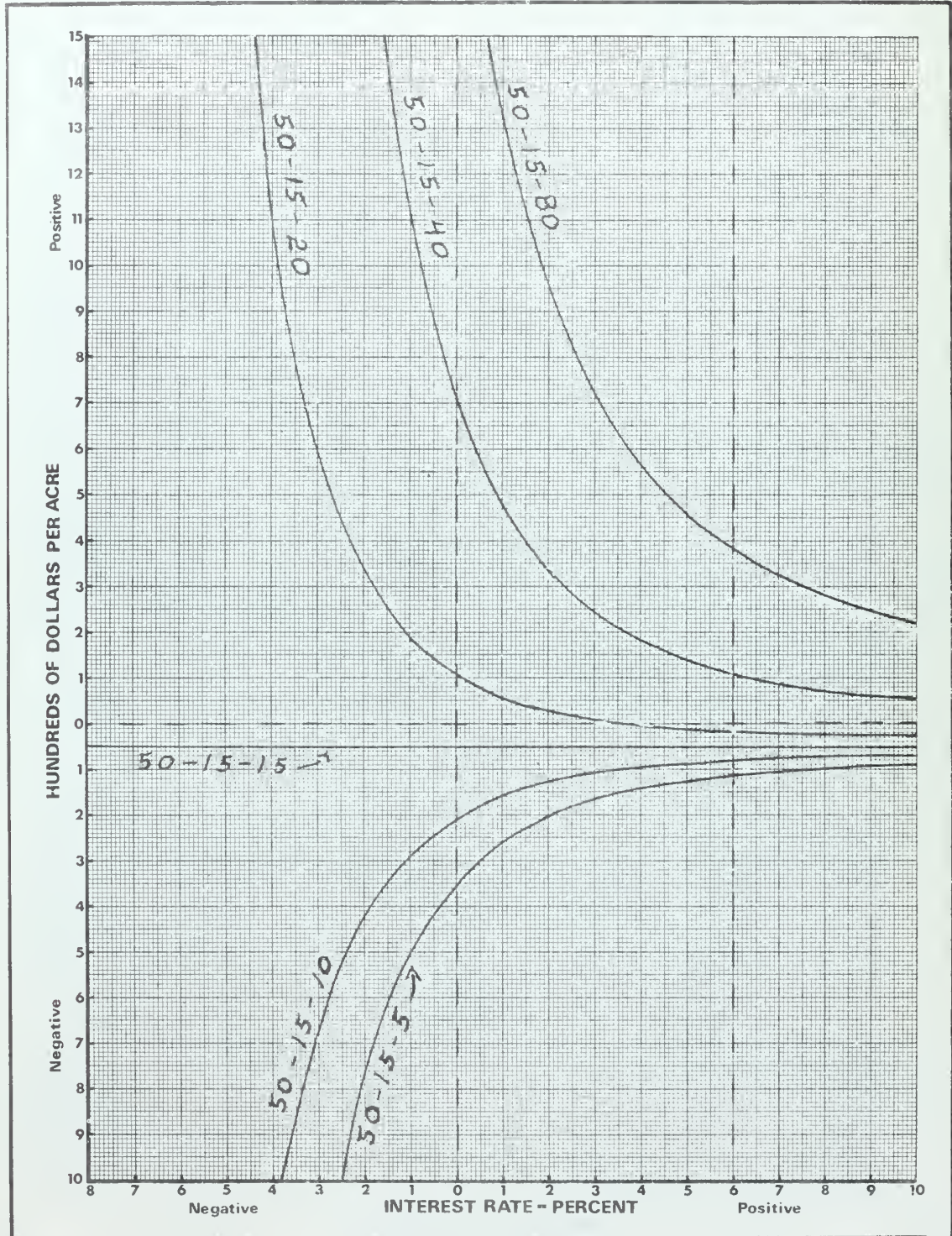
# PRESENT NET WORTH

## Alternatives

50-15-(15-10-20-40-80)

Lodgepole Pine--Site Index 60

Precommercial Thin Only-- @ 20 Years of Age



BENEFIT-COST ANALYSIS--PRECOMMERCIAL THIN @ AGE 20 ONLY  
 LODGEPOLE PINE SITE INDEX 60, FINAL HARVEST @ 100 YEARS; HORAK

BENEFIT-COST RATIO (B/C) AT ALTERNATIVE RATES OF INTEREST  
 PRESENT NET WORTH (PNW) AT ALTERNATIVE RATES OF INTEREST

RATE	50-15-05				50-15-10				50-15-20				50-15-40				50-15-80			
	*PNW	B/C*	*PNW	H/C*	*PNW	B/C*	*PNW	H/C*	*PNW	B/C*	*PNW	H/C*	*PNW	B/C*	*PNW	B/C*	*PNW	B/C*		
-10.00	-156555.81	0.33	-74302.90	0.67	78202.90	1.33	391214.52	2.67	1017237.75	5.33										
-9.00	-72667.51	0.33	-36358.76	0.67	36258.76	1.33	181493.78	2.67	471963.03	5.33										
-8.00	-34477.41	0.33	-17263.70	0.67	17163.70	1.33	86018.52	2.66	223728.16	5.33										
-7.00	-16759.50	0.33	-8409.75	0.67	8309.75	1.33	41748.74	2.66	108626.73	5.32										
-6.00	-8345.35	0.33	-4222.68	0.66	4122.66	1.33	20813.39	2.66	54194.80	5.31										
-5.00	-4349.48	0.33	-2199.74	0.66	2099.74	1.32	10698.71	2.65	27898.05	5.29										
-4.00	-2348.24	0.33	-1194.12	0.66	1099.12	1.31	5695.60	2.63	14888.56	5.26										
-3.00	-1332.19	0.32	-691.10	0.65	591.10	1.30	3155.49	2.60	8284.27	5.20										
-2.00	-801.13	0.32	-425.57	0.64	395.57	1.28	1827.83	2.55	4832.36	5.11										
-1.00	-514.43	0.31	-282.21	0.62	182.21	1.24	1111.07	2.49	2965.77	4.98										
0.00	-354.00	0.30	-202.00	0.60	102.00	1.20	710.00	2.40	1926.00	4.81										
1.00	-260.66	0.29	-155.33	0.58	55.33	1.15	476.65	2.30	1319.30	4.60										
2.00	-214.05	0.27	-127.02	0.55	27.02	1.10	335.12	2.19	951.32	4.34										
3.00	-168.21	0.26	-109.10	0.52	9.10	1.04	245.51	2.08	718.34	4.16										
4.00	-144.51	0.25	-97.26	0.49	-2.74	0.99	186.28	1.97	564.34	3.94										
5.00	-128.19	0.23	-89.09	0.47	-10.91	0.93	145.47	1.87	458.23	3.74										
6.00	-116.50	0.22	-83.25	0.44	-16.75	0.89	116.25	1.78	382.24	3.55										
7.00	-107.83	0.21	-78.91	0.42	-21.09	0.85	94.57	1.69	325.07	3.36										
8.00	-101.19	0.20	-75.60	0.40	-24.40	0.81	77.98	1.62	292.74	3.23										
9.00	-95.98	0.19	-72.99	0.39	-27.01	0.77	64.94	1.55	248.84	3.09										
10.00	-91.78	0.19	-70.89	0.37	-29.11	0.74	54.45	1.48	221.57	2.97										
11.00	-88.34	0.18	-69.17	0.36	-30.83	0.71	45.84	1.43	199.19	2.85										
12.00	-85.46	0.17	-67.73	0.34	-32.27	0.69	38.66	1.37	180.51	2.75										
13.00	-83.03	0.17	-66.51	0.33	-33.49	0.66	32.57	1.33	164.69	2.65										
14.00	-80.94	0.16	-65.47	0.32	-34.53	0.64	27.35	1.28	151.12	2.57										
15.00	-79.13	0.16	-64.57	0.31	-35.43	0.62	22.83	1.24	139.36	2.49										

Present Net Worth  
Benefit/Cost Ratio  
75 - 5 - (5-10-20-40-80)

Lodgepole Pine--Site Index 60

Precommercial Thin Only--At 20 Years of Age

Average stand volume-mature timber	20,000	Bd. Ft. acre
Increase in volume due to thinning	30,400	Bd. Ft. acre
Investment period	80	Years
Annual allowable cut increment increase	380	Bd. Ft.
Additional acreage cut and reforested 1/	0.019	Acres
Cost of reforestation @\$50.00 per acre 1/	\$0.95	Annually

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Code <u>\$75</u>	Cost to PCT one acre		
<u>5</u>	Cost to sell one MBF of mature timber		
<u>5</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio @ <u>6%</u>	=	<u>0.31</u>
Present net worth	@ <u>6%</u>	=	<u>\$-75.00</u>

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Code <u>\$75</u>	Cost to PCT one acre		
<u>5</u>	Cost to sell one MBF of mature timber		
<u>10</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio @ <u>6%</u>	=	<u>0.61</u>
Present net worth	@ <u>6%</u>	=	<u>\$-41.75</u>

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Code <u>\$75</u>	Cost of PCT one acre		
<u>5</u>	Cost to sell one MBF of mature timber		
<u>20</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio @ <u>6%</u>	=	<u>1.23</u>
Present net worth	@ <u>6%</u>	=	<u>\$24.75</u>

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Code <u>\$75</u>	Cost to PCT one acre		
<u>5</u>	Cost to sell one MBF of mature timber		
<u>40</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio @ <u>6%</u>	=	<u>2.46</u>
Present net worth	@ <u>6%</u>	=	<u>\$157.75</u>

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Code <u>\$75</u>	Cost of PCT one acre		
<u>5</u>	Cost to sell one MBF of mature timber		
<u>80</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio @ <u>6%</u>	=	<u>4.91</u>
Present net worth	@ <u>6%</u>	=	<u>\$423.74</u>

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1/ Site Index 60 Lodgepole pine is generally clear-cut and can be regenerated naturally; therefore, no reforestation costs were included in the above B/C analysis. If you wish to include reforestation costs of \$50.00 per acre, note that this is equivalent to adding \$5.00 per MBF to the cost of selling timber.

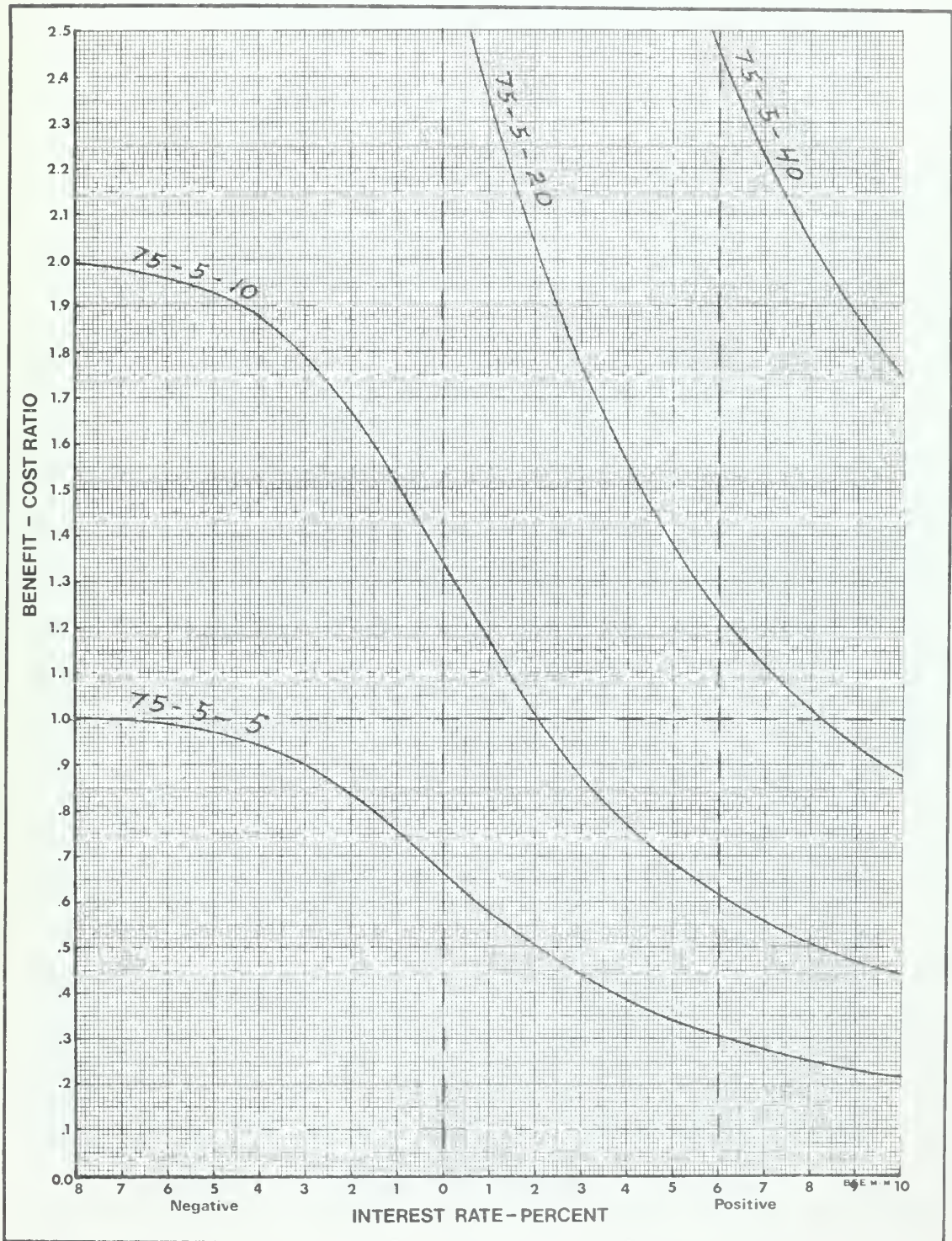
# BENEFIT/COST RATIO

## Alternatives

75-5-(5-10-20-40-80)

Lodgepole Pine--Site Index 60

Precommercial Thin Only--@ 20 Years of Age



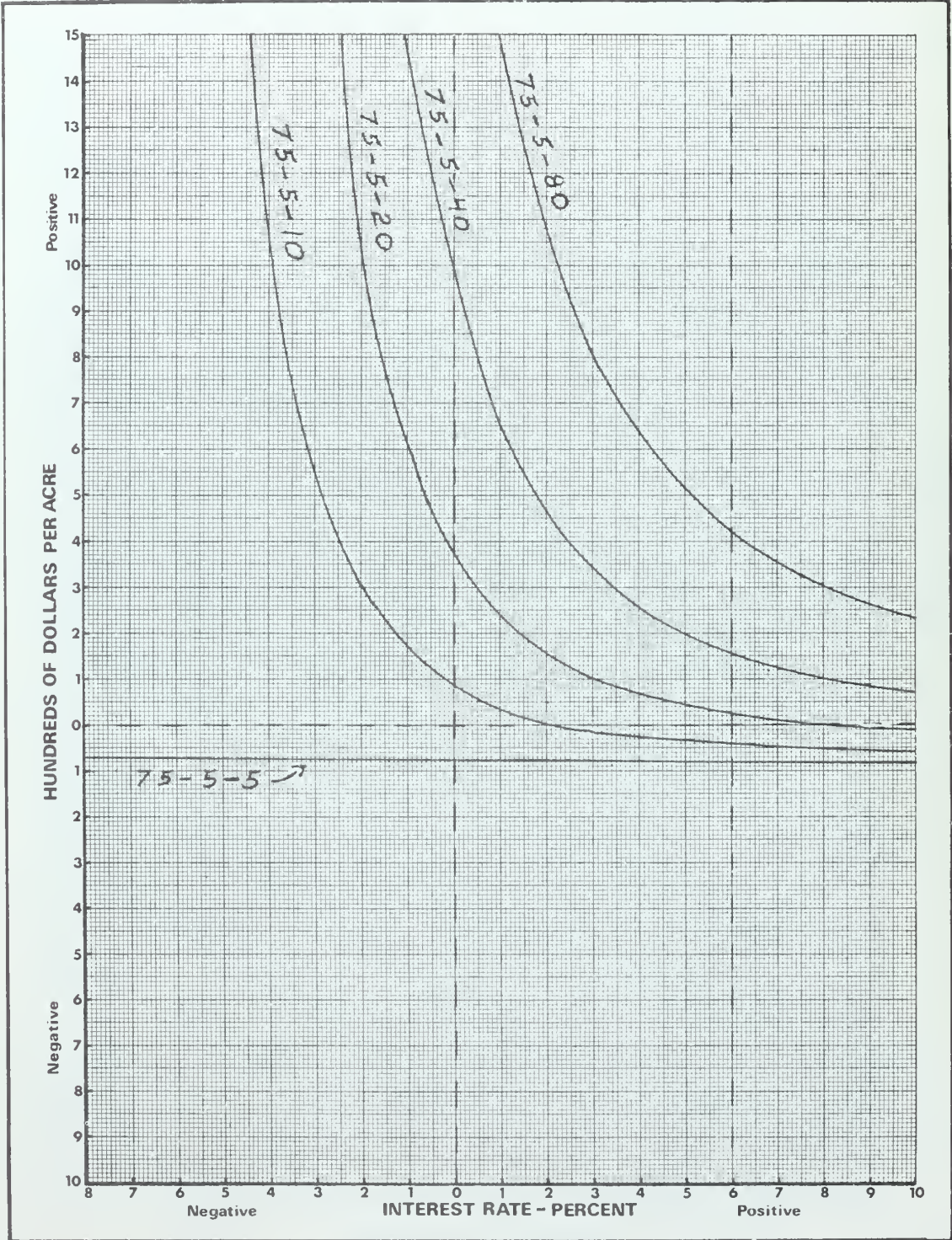
# PRESENT NET WORTH

## Alternatives

75-5-(5-10-20-40-80)

Lodgepole Pine--Site Index 60

Precommercial Thin Only--@ 20 Years of Age



BENEFIT-COST ANALYSIS--PRECOMMERCIAL THIN @ AGE 20 ONLY

PROBLEM NO. 3 LODGEPOLE PINE/ SIIE INDEX 60/ FINAL HARVEST @ 100 YEARS/ HORAK

BENEFIT-COST RATIO (B/C) AT ALTERNATIVE RATES OF INTEREST  
PRESENT NET WORTH (PNW) AT ALTERNATIVE RATES OF INTEREST

RATE	MANAGEMENT ALTERNATIVE									
	75-05-05	75-05-10	75-05-20	75-05-40	75-05-80					
	*PNW	B/C*	*PNW	B/C*	*PNW	B/C*				
-10.00	-75.00	1.00	78177.90	2.00	234683.71	4.00	547695.33	7.99	1173718.56	15.98
-9.00	-75.00	1.00	36233.76	2.00	108551.27	3.99	254086.29	7.98	544556.34	15.97
-8.00	-75.00	1.00	17138.70	1.99	51566.11	3.98	120420.93	7.97	258130.56	15.93
-7.00	-75.00	0.99	8244.75	1.98	25004.25	3.96	58443.24	7.93	125321.23	15.86
-6.00	-75.00	0.98	4097.68	1.96	12443.03	3.93	29133.74	7.86	62315.16	15.72
-5.00	-75.00	0.97	2074.74	1.93	6374.23	3.87	14973.19	7.73	32171.13	15.46
-4.00	-75.00	0.94	1074.12	1.88	3372.36	3.75	7968.84	7.51	17161.80	15.02
-3.00	-75.00	0.90	566.10	1.79	1848.29	3.58	4412.68	7.16	9541.46	14.32
-2.00	-75.00	0.83	300.57	1.67	1051.70	3.33	2553.96	6.67	5558.49	13.34
-1.00	-75.00	0.76	157.21	1.51	621.64	3.02	1550.49	6.05	3408.20	12.09
0.00	-75.00	0.67	77.00	1.34	341.00	2.68	989.00	5.36	2205.00	10.71
1.00	-75.00	0.58	30.33	1.17	240.99	2.34	662.31	4.67	1504.96	9.35
2.00	-75.00	0.51	2.02	1.01	156.07	2.03	464.17	4.05	1080.37	8.11
3.00	-75.00	0.44	-15.90	0.88	102.31	1.76	338.72	3.53	811.54	7.05
4.00	-75.00	0.39	-27.74	0.77	66.77	1.55	255.80	3.09	633.85	6.18
5.00	-75.00	0.34	-35.91	0.69	42.28	1.37	198.66	2.74	511.42	5.48
6.00	-75.00	0.31	-41.75	0.61	24.75	1.23	157.75	2.46	423.74	4.91
7.00	-75.00	0.28	-46.09	0.56	11.74	1.11	127.59	2.23	358.70	4.45
8.00	-75.00	0.25	-49.40	0.51	1.79	1.02	104.17	2.04	308.93	4.07
9.00	-75.00	0.23	-52.01	0.47	-6.04	0.94	85.91	1.88	269.82	3.75
10.00	-75.00	0.22	-54.11	0.44	-12.33	0.87	71.23	1.74	238.35	3.49
11.00	-75.00	0.20	-55.83	0.41	-17.50	0.81	59.18	1.63	212.52	3.26
12.00	-75.00	0.19	-57.27	0.38	-21.81	0.76	49.12	1.53	190.97	3.06
13.00	-75.00	0.18	-58.49	0.36	-25.46	0.72	40.60	1.44	172.72	2.89
14.00	-75.00	0.17	-59.53	0.34	-28.59	0.68	33.30	1.37	157.06	2.74
15.00	-75.00	0.16	-60.43	0.33	-31.30	0.65	26.97	1.30	143.50	2.60

Present Net Worth  
Benefit/Cost Ratio  
75-10-(5-10-20-40-80)  
Lodgepole Pine--Site Index 60

Precommercial Thin Only--At 20 Years of Age

Average stand volume-mature timber	20,000	Bd. Ft. acre
Increase in volume due to thinning	30,400	Bd. Ft. acre
Investment period	80	Years
Annual allowable cut increment increase	380	Bd. Ft.
Additional acreage cut and reforested <u>1/</u>	0.019	Acres
Cost of reforestation @\$50.00 per acre <u>1/</u>	\$0.95	Annually

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Code <u>\$75</u>	Cost to PCT one acre	
<u>10</u>	Cost to sell one MBF of mature timber	
<u>5</u>	Income from sale of one MBF of mature timber	
<u>B/C</u>	Ratio @ <u>6%</u>	= <u>0.23</u>
Present net worth	@ <u>6%</u>	= <u>\$-108.25</u>

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Code <u>\$75</u>	Cost to PCT one acre	
<u>10</u>	Cost to sell one MBF of mature timber	
<u>10</u>	Income from sale of one MBF of mature timber	
<u>B/C</u>	Ratio @ <u>6%</u>	= <u>0.47</u>
Present net worth	@ <u>6%</u>	= <u>\$-75.00</u>

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Code <u>\$75</u>	Cost of PCT one acre	
<u>10</u>	Cost to sell one MBF of mature timber	
<u>20</u>	Income from sale of one MBF of mature timber	
<u>B/C</u>	Ratio @ <u>6%</u>	= <u>0.94</u>
Present net worth	@ <u>6%</u>	= <u>\$-8.50</u>

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Code <u>\$75</u>	Cost to PCT one acre	
<u>10</u>	Cost to sell one MBF of mature timber	
<u>40</u>	Income from sale of one MBF of mature timber	
<u>B/C</u>	Ratio @ <u>6%</u>	= <u>1.88</u>
Present net worth	@ <u>6%</u>	= <u>\$124.50</u>

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Code <u>\$75</u>	Cost of PCT one acre	
<u>10</u>	Cost to sell one MBF of mature timber	
<u>80</u>	Income from sale of one MBF of mature timber	
<u>B/C</u>	Ratio @ <u>6%</u>	= <u>3.76</u>
Present net worth	@ <u>6%</u>	= <u>\$390.49</u>

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1/ Site Index 60 Lodgepole pine is generally clear-cut and can be regenerated naturally; therefore, no reforestation costs were included in the above B/C analysis. If you wish to include reforestation costs of \$50.00 per acre, note that this is equivalent to adding \$5.00 per MBF to the cost of selling timber.

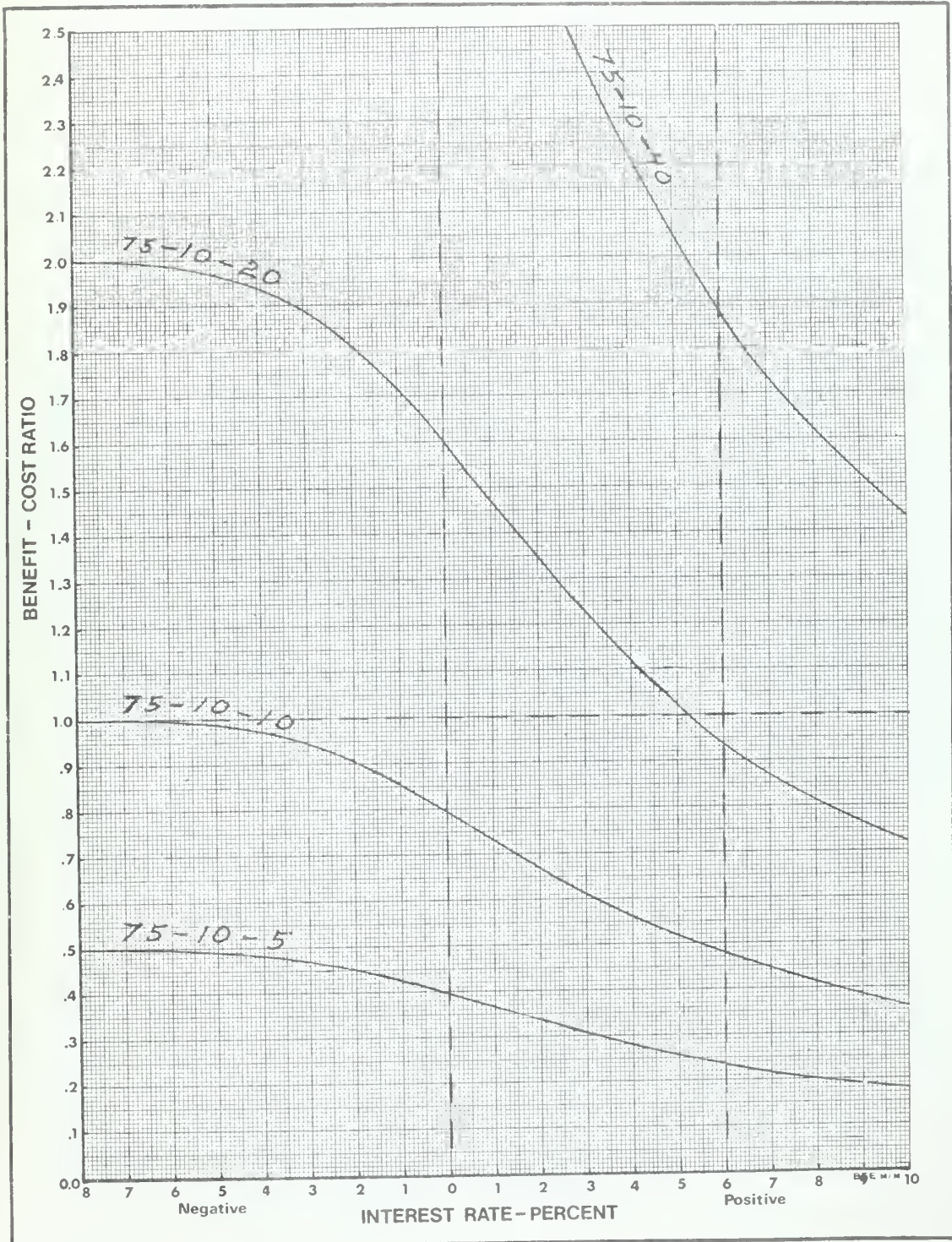


# BENEFIT/COST RATIO Alternatives

75-10-(5-10-20-40-80)

Lodgepole Pine--Site Index 60

Precommercial Thin Only--@ 20 Years of Age



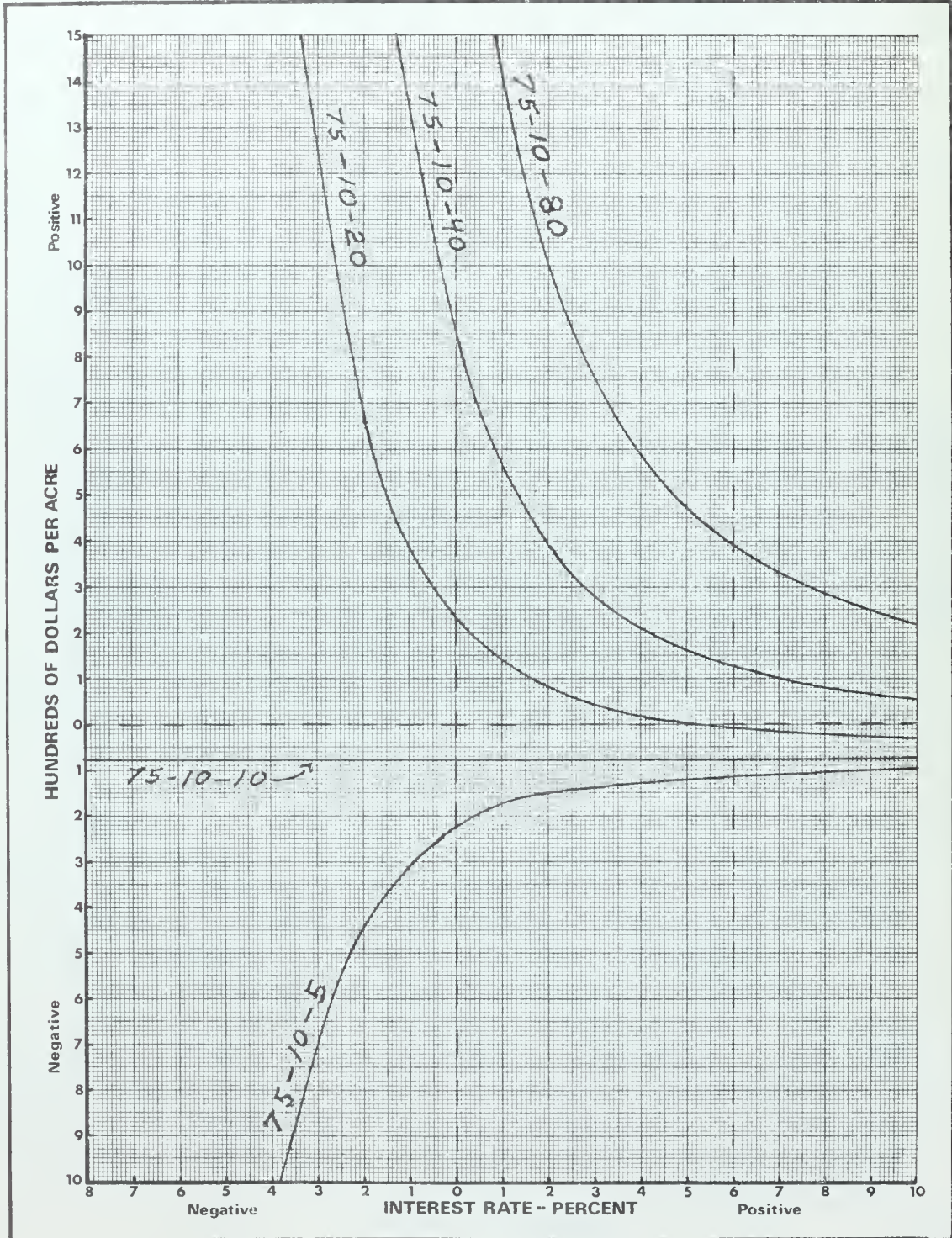
# PRESENT NET WORTH

## Alternatives

75-10-(5-10-20-40-80)

Lodgepole Pine--Site Index 60

Precommercial Thin Only--@ 20 Years of Age



BENEFIT-COST ANALYSIS--PRECOMMERCIAL THIN @ AGE 20 ONLY

PROBLEM NO. 3 LODGEPOLE PINE/ SITE INDEX 60/ FINAL HARVEST @ 100 YEARS/ HORAK

BENEFIT-COST RATIO (B/C) AT ALTERNATIVE RATES OF INTEREST  
PRESENT NET WORTH (PNW) AT ALTERNATIVE RATES OF INTEREST

MANAGEMENT ALTERNATIVE

RATE	75-10-05			75-10-20			75-10-40			75-10-80		
	*PNW	B/C*	*PNW	B/C*	*PNW	B/C*	*PNW	B/C*	*PNW	B/C*	*PNW	B/C*
-10.00	-78327.90	0.50	-75.00	1.00	156430.61	2.00	469442.42	4.00	1095465.65	8.00	8.00	
-9.00	-36383.76	0.50	-75.00	1.00	72542.51	2.00	21777.54	4.00	508247.59	7.99	7.99	
-8.00	-17286.70	0.50	-75.00	1.00	34352.41	2.00	103207.23	3.99	240916.86	7.98	7.98	
-7.00	-8434.75	0.50	-75.00	1.00	16644.50	1.99	50083.49	3.98	116961.48	7.96	7.96	
-6.00	-4247.68	0.50	-75.00	0.99	8270.35	1.98	24961.06	3.96	58342.48	7.93	7.93	
-5.00	-2224.74	0.49	-75.00	0.98	4224.48	1.97	12823.45	3.93	30021.39	7.86	7.86	
-4.00	-1224.12	0.48	-75.00	0.97	2223.24	1.94	6819.72	3.87	16012.68	7.75	7.75	
-3.00	-716.10	0.47	-75.00	0.94	1207.19	1.89	3771.58	3.78	8900.36	7.56	7.56	
-2.00	-450.57	0.45	-75.00	0.91	676.13	1.82	2178.40	3.64	5162.93	7.27	7.27	
-1.00	-307.21	0.43	-75.00	0.86	389.43	1.72	1318.28	3.44	3175.99	6.89	6.89	
0.00	-227.00	0.40	-75.00	0.80	229.00	1.60	837.00	3.21	2053.00	6.42	6.42	
1.00	-180.33	0.37	-75.00	0.74	135.66	1.47	556.98	2.95	1399.63	5.90	5.90	
2.00	-152.02	0.34	-75.00	0.67	79.05	1.35	387.15	2.69	1003.35	5.38	5.38	
3.00	-134.10	0.31	-75.00	0.61	43.21	1.22	279.02	2.45	752.44	4.89	4.89	
4.00	-122.26	0.28	-75.00	0.56	19.51	1.12	208.54	2.23	586.60	4.46	4.46	
5.00	-114.09	0.26	-75.00	0.51	3.19	1.02	159.57	2.04	472.33	4.08	4.08	
6.00	-105.25	0.23	-75.00	0.47	-8.50	0.94	124.50	1.88	390.49	3.76	3.76	
7.00	-103.91	0.22	-75.00	0.44	-17.17	0.87	98.48	1.74	329.79	3.48	3.48	
8.00	-100.60	0.20	-75.00	0.41	-23.81	0.81	78.57	1.62	283.34	3.25	3.25	
9.00	-97.99	0.19	-75.00	0.38	-29.02	0.76	62.93	1.52	246.03	3.04	3.04	
10.00	-95.89	0.18	-75.00	0.36	-33.22	0.72	50.34	1.43	217.46	2.86	2.86	
11.00	-94.17	0.17	-75.00	0.34	-36.66	0.68	40.01	1.35	193.35	2.71	2.71	
12.00	-92.73	0.16	-75.00	0.32	-39.54	0.64	31.39	1.28	173.24	2.57	2.57	
13.00	-91.51	0.15	-75.00	0.31	-41.97	0.61	24.09	1.22	156.20	2.45	2.45	
14.00	-90.47	0.15	-75.00	0.29	-44.06	0.58	17.83	1.17	141.59	2.34	2.34	
15.00	-89.57	0.14	-75.00	0.28	-45.87	0.56	12.40	1.12	128.93	2.24	2.24	

Present Net Worth  
Benefit/Cost Ratio  
75-15-(5-10-20-40-80)

Lodgepole Pine--Site Index 60

Precommercial Thin Only--At 20 Years of Age

Average stand volume-mature timber	20,000	Bd. Ft. acre
Increase in volume due to thinning	30,400	Bd. Ft. acre
Investment period	80	Years
Annual allowable cut increment increase	380	Bd. Ft.
Additional acreage cut and reforested <u>1/</u>	0.019	Acres
Cost of reforestation @\$50.00 per acre <u>1/</u>	\$0.95	Annually

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Code <u>\$75</u>	Cost to PCT one acre		
<u>15</u>	Cost to sell one MBF of mature timber		
<u>5</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio @ <u>6%</u>	=	<u>0.19</u>
Present net worth	@ <u>6%</u>	=	<u>\$-144.50</u>

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Code <u>\$75</u>	Cost to PCT one acre		
<u>15</u>	Cost to sell one MBF of mature timber		
<u>10</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio @ <u>6%</u>	=	<u>0.38</u>
Present net worth	@ <u>6%</u>	=	<u>\$-108.25</u>

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Code <u>\$75</u>	Cost of PCT one acre		
<u>15</u>	Cost to sell one MBF of mature timber		
<u>20</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio @ <u>6%</u>	=	<u>0.76</u>
Present net worth	@ <u>6%</u>	=	<u>\$-41.75</u>

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Code <u>\$75</u>	Cost to PCT one acre		
<u>15</u>	Cost to sell one MBF of mature timber		
<u>40</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio @ <u>6%</u>	=	<u>1.52</u>
Present net worth	@ <u>6%</u>	=	<u>\$91.25</u>

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Code <u>\$75</u>	Cost of PCT one acre		
<u>15</u>	Cost to sell one MBF of mature timber		
<u>80</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio @ <u>6%</u>	=	<u>3.04</u>
Present net worth	@ <u>6%</u>	=	<u>\$357.24</u>

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1/ Site Index 60 Lodgepole pine is generally clear-cut and can be regenerated naturally; therefore, no reforestation costs were included in the above B/C analysis. If you wish to include reforestation costs of \$50.00 per acre, note that this is equivalent to adding \$5.00 per MBF to the cost of selling timber.

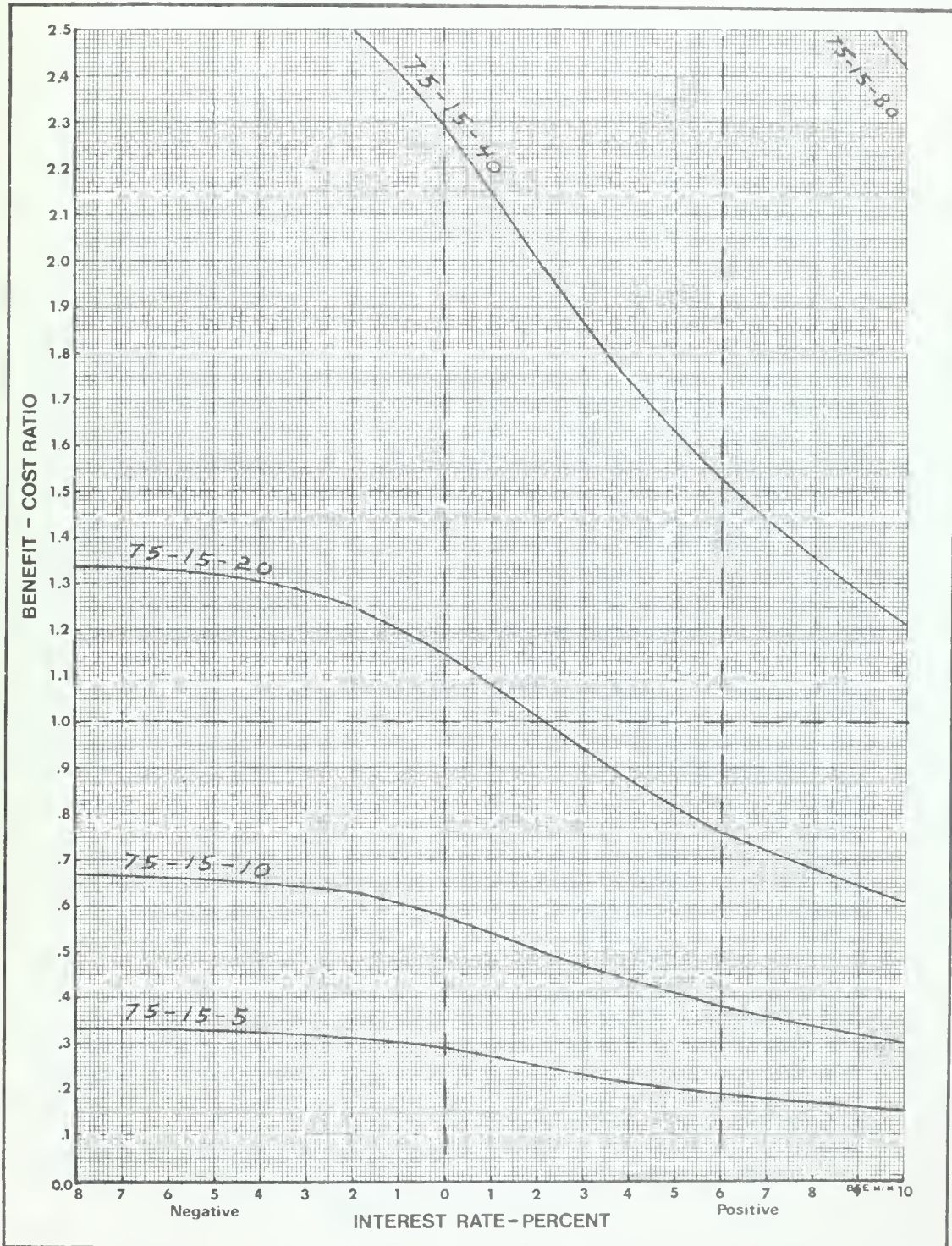
# BENEFIT/COST RATIO

## Alternatives

75-15-(5-10-20-40-80)

Lodgepole Pine--Site Index 60

Precommercial Thin Only--@ 20 Years of Age



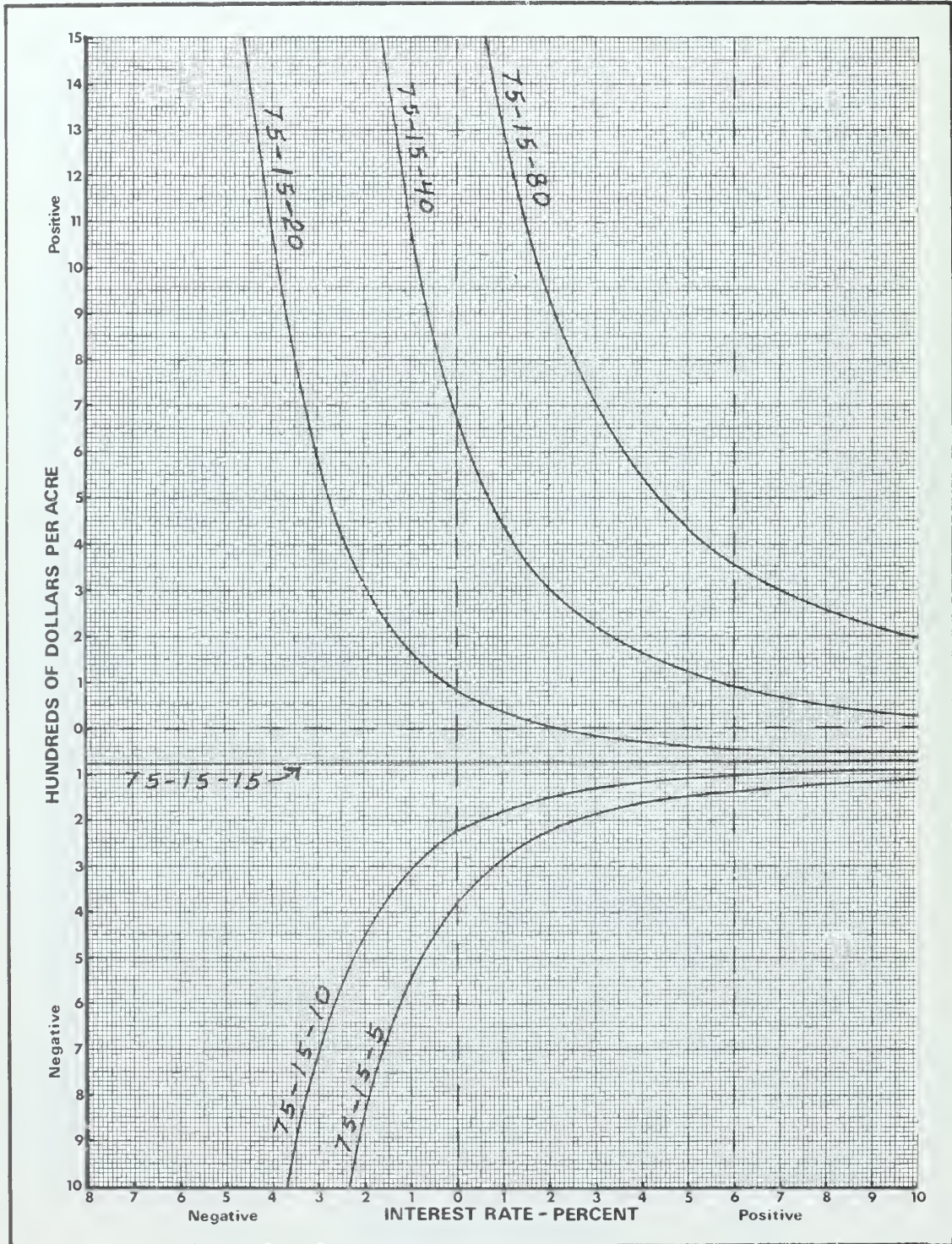
# PRESENT NET WORTH

## Alternatives

75-15-(5-10-20-40-80)

Lodgepole Pine--Site Index 60

Precommercial Thin Only-- @ 20 Years of Age



BENEFIT-COST ANALYSIS--PRECOMMERCIAL THIN @ AGE 20 ONLY

PROBLEM NO. 3 LOOGEPOLE PINE/ SITE INDEX 60/ FINAL HARVEST @ 100 YEARS/ HORAK

BENEFIT-COST RATIO (B/C) AT ALTERNATIVE RATES OF INTEREST  
PRESENT NET WORTH (PNW) AT ALTERNATIVE RATES OF INTEREST

RATE	75-15-05			75-15-10			75-15-20			75-15-40			75-15-80		
	*PNW	B/C*	*PNW	B/C*	*PNW	B/C*	*PNW	B/C*	*PNW	B/C*	*PNW	B/C*	*PNW	B/C*	
-10.00	-156580.81	0.33	-78327.90	0.67	78177.90	1.33	391189.52	2.67	1017212.75	5.33					
-9.00	-72692.51	0.33	-36383.76	0.67	36233.76	1.33	181468.78	2.66	471938.83	5.33					
-8.00	-34502.41	0.33	-17288.70	0.67	17138.70	1.33	85993.52	2.66	223703.16	5.33					
-7.00	-16794.50	0.33	-8434.75	0.66	8284.75	1.33	41723.74	2.66	108601.73	5.32					
-6.00	-8470.35	0.33	-4247.68	0.66	4097.68	1.33	20788.39	2.65	54169.80	5.30					
-5.00	-4374.48	0.33	-2224.74	0.66	2074.74	1.32	10673.71	2.64	27871.65	5.27					
-4.00	-2373.24	0.33	-1224.12	0.65	1074.12	1.30	5670.60	2.61	14863.56	5.22					
-3.00	-1357.19	0.32	-716.10	0.64	566.10	1.28	3130.49	2.57	8259.27	5.13					
-2.00	-826.13	0.31	-450.57	0.63	300.57	1.25	1802.83	2.50	4807.36	5.00					
-1.00	-539.43	0.30	-307.21	0.60	157.21	1.20	1086.07	2.41	2943.77	4.81					
0.00	-379.00	0.29	-227.00	0.57	77.00	1.15	685.00	2.29	1901.00	4.58					
1.00	-285.66	0.27	-180.33	0.54	30.33	1.08	451.65	2.16	1294.30	4.31					
2.00	-229.05	0.25	-152.02	0.50	2.02	1.01	310.12	2.01	926.32	4.03					
3.00	-193.21	0.23	-134.10	0.47	-15.90	0.94	220.51	1.87	693.34	3.75					
4.00	-169.51	0.22	-122.26	0.44	-27.74	0.87	161.28	1.74	539.34	3.49					
5.00	-153.19	0.20	-114.09	0.41	-35.91	0.81	120.47	1.63	433.23	3.25					
6.00	-141.50	0.19	-108.25	0.38	-41.75	0.76	81.25	1.52	357.24	3.04					
7.00	-132.83	0.18	-103.91	0.36	-46.09	0.72	69.57	1.43	300.87	2.86					
8.00	-126.19	0.17	-100.60	0.34	-49.40	0.67	52.98	1.35	257.74	2.70					
9.00	-120.98	0.16	-97.99	0.32	-52.01	0.64	39.94	1.28	223.84	2.55					
10.00	-116.78	0.15	-95.89	0.30	-54.11	0.61	29.45	1.21	196.57	2.43					
11.00	-113.34	0.14	-94.17	0.29	-55.83	0.58	20.84	1.16	174.19	2.31					
12.00	-110.46	0.14	-92.73	0.28	-57.27	0.55	13.66	1.11	155.51	2.21					
13.00	-108.03	0.13	-91.51	0.27	-58.49	0.53	7.57	1.06	139.69	2.12					
14.00	-105.94	0.13	-90.47	0.25	-59.53	0.51	2.35	1.02	126.12	2.04					
15.00	-104.13	0.12	-89.57	0.25	-60.43	0.49	-2.17	0.98	114.36	1.96					

Present Net Worth  
Benefit/Cost Ratio  
 $100 - 5 - (5 - 10 - 20 - 40 - 80)$

Lodgepole Pine--Site Index 60

Precommercial Thin Only--At 20 Years of Age

Average stand volume-mature timber	20,000	Bd. Ft. acre
Increase in volume due to thinning	30,400	Bd. Ft. acre
Investment period	80	Years
Annual allowable cut increment increase	380	Bd. Ft.
Additional acreage cut and reforested <u>1/</u>	0.019	Acres
Cost of reforestation @\$50.00 per acre <u>1/</u>	\$0.95	Annually

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Code <u>\$100</u>	Cost to PCT one acre		
<u>5</u>	Cost to sell one MBF of mature timber		
<u>5</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio @ <u>6%</u>	=	<u>.25</u>
Present net worth	@ <u>6%</u>	=	<u>\$ -100.00</u>

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Code <u>\$100</u>	Cost to PCT one acre		
<u>5</u>	Cost to sell one MBF of mature timber		
<u>10</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio @ <u>6%</u>	=	<u>.50</u>
Present net worth	@ <u>6%</u>	=	<u>\$ -66.75</u>

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Code <u>\$100</u>	Cost of PCT one acre		
<u>5</u>	Cost to sell one MBF of mature timber		
<u>20</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio @ <u>6%</u>	=	<u>1.00</u>
Present net worth	@ <u>6%</u>	=	<u>\$ -0.25</u>

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Code <u>\$100</u>	Cost to PCT one acre		
<u>5</u>	Cost to sell one MBF of mature timber		
<u>40</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio @ <u>6%</u>	=	<u>2.00</u>
Present net worth	@ <u>6%</u>	=	<u>\$ 132.75</u>

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Code <u>\$100</u>	Cost of PCT one acre		
<u>5</u>	Cost to sell one MBF of mature timber		
<u>80</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio @ <u>6%</u>	=	<u>3.99</u>
Present net worth	@ <u>6%</u>	=	<u>\$ 398.74</u>

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1/ Site Index 60 Lodgepole pine is generally clear-cut and can be regenerated naturally; therefore, no reforestation costs were included in the above B/C analysis. If you wish to include reforestation costs of \$50.00 per acre, note that this is equivalent to adding \$5.00 per MBF to the cost of selling timber.



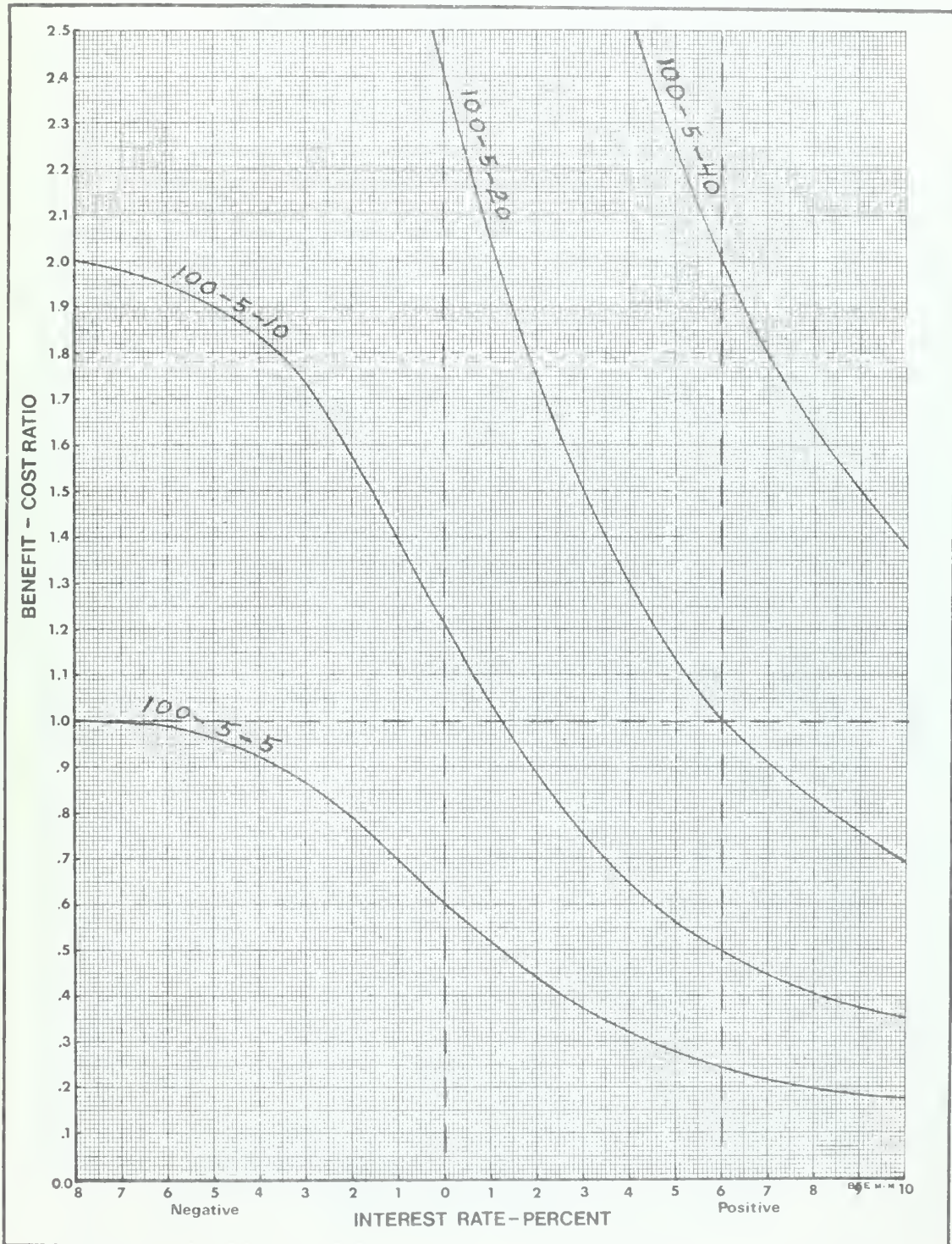
# BENEFIT/COST RATIO

## Alternatives

100-5-(5-10-20-40-80)

Lodgepole Pine--Site Index 60

Precommercial Thin Only--@ 20 Years of Age



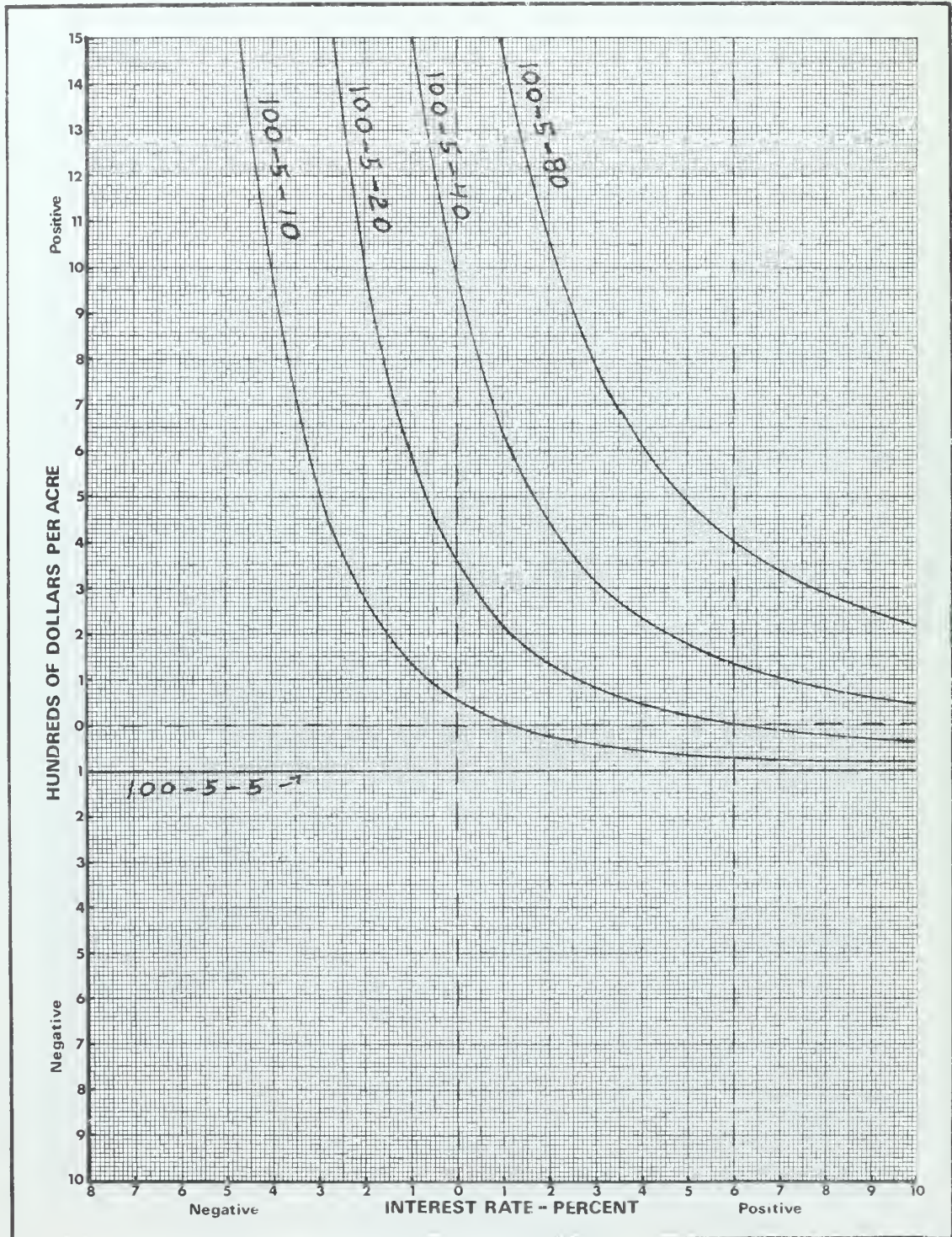
# PRESENT NET WORTH

## Alternatives

100-5-(5-10-20-40-80)

Lodgepole Pine--Site Index 60

Precommercial Thin Only--@ 20 Years of Age



REBENEFIT-COST ANALYSIS--PRECOMMERCIAL THIN @ AGE 20 ONLY  
 LODGEPOLE PINE; SITE INDEX 60; FINAL HARVEST @ 100 YEARS; HUKAK

BENEFIT-COST RATIO (B/C) AT ALTERNATIVE RATES OF INTEREST  
 PRESENT NET WORTH (PNW) AT ALTERNATIVE RATES OF INTEREST

RATE	MANAGEMENT ALTERNATIVE									
	100-5-05		100-5-10		100-5-20					
	*PNW	B/C*	*PNW	B/C*	*PNW	B/C*				
-10.00	-100.00	1.00	78152.90	2.00	234654.71	3.99	547670.33	7.99	1173593.56	15.94
-8.00	-100.00	1.00	36206.70	1.99	108626.27	3.99	254061.29	7.98	544531.34	13.96
-6.00	-100.00	0.99	17113.70	1.99	51541.11	3.94	120395.93	7.95	258105.56	15.91
-4.00	-100.00	0.99	8259.75	1.96	24979.25	3.95	58418.24	7.91	125296.23	15.81
-2.00	-100.00	0.98	4072.68	1.95	12414.03	3.91	29104.74	7.81	62440.16	15.63
0.00	-100.00	0.96	2049.74	1.91	6342.23	3.82	14948.19	7.64	32146.13	15.29
2.00	-100.00	0.92	1049.12	1.84	3347.36	3.68	7943.84	7.35	17136.80	14.72
4.00	-100.00	0.87	541.10	1.73	1623.29	3.46	4387.68	6.92	9516.46	13.44
6.00	-100.00	0.79	275.57	1.58	1026.70	3.16	2523.96	6.32	5533.49	12.64
8.00	-100.00	0.70	132.21	1.40	596.64	2.80	1525.49	5.59	3383.20	11.14
10.00	-100.00	0.60	52.00	1.21	350.00	2.41	964.00	4.83	2180.00	9.65
12.00	-100.00	0.51	5.33	1.03	215.92	2.05	637.31	4.10	1479.96	8.21
14.00	-100.00	0.44	-22.98	0.87	131.07	1.74	439.17	3.44	1055.37	6.96
16.00	-100.00	0.37	-40.99	0.74	77.31	1.49	313.72	2.97	756.54	5.94
18.00	-100.00	0.32	-52.74	0.64	41.77	1.29	230.80	2.57	608.85	5.13
20.00	-100.00	0.28	-60.91	0.56	17.28	1.12	173.66	2.25	486.47	4.50
22.00	-100.00	0.25	-66.75	0.50	-0.25	1.00	132.75	2.00	398.74	3.99
24.00	-100.00	0.22	-71.09	0.45	-13.26	0.90	102.39	1.79	333.70	3.59
26.00	-100.00	0.20	-74.40	0.41	-23.21	0.82	79.17	1.63	283.93	3.26
28.00	-100.00	0.19	-77.01	0.37	-31.04	0.75	60.91	1.50	244.82	2.99
30.00	-100.00	0.17	-79.11	0.35	-37.33	0.69	46.23	1.33	213.35	2.76
32.00	-100.00	0.16	-80.83	0.32	-42.50	0.64	34.18	1.29	187.52	2.57
34.00	-100.00	0.15	-82.27	0.30	-46.81	0.60	24.12	1.20	165.97	2.41
36.00	-100.00	0.14	-83.49	0.28	-50.46	0.57	15.00	1.13	147.72	2.27
38.00	-100.00	0.13	-84.53	0.27	-53.59	0.54	8.30	1.07	132.06	2.14
40.00	-100.00	0.13	-85.43	0.25	-56.30	0.51	1.97	1.02	118.50	2.03

Present Net Worth  
Benefit/Cost Ratio  
100-10-(5-10-20-40-80)  
Lodgepole Pine--Site Index 60  
Precommercial Thin Only--At 20 Years of Age

Average stand volume-mature timber	20,000	Bd. Ft. acre
Increase in volume due to thinning	30,400	Bd. Ft. acre
Investment period	80	Years
Annual allowable cut increment increase	380	Bd. Ft.
Additional acreage cut and reforested <u>1/</u>	0.019	Acres
Cost of reforestation @\$50.00 per acre <u>1/</u>	.95	Annually

Code	<u>\$100</u>	Cost to PCT one acre		
	<u>10</u>	Cost to sell one MBF of mature timber		
	<u>5</u>	Income from sale of one MBF of mature timber		
	<u>B/C</u>	Ratio @ <u>6%</u>	=	<u>.20</u>
		Present net worth @ <u>6%</u>	=	<u>\$ -133.25</u>

Code	<u>\$100</u>	Cost to PCT one acre		
	<u>10</u>	Cost to sell one MBF of mature timber		
	<u>10</u>	Income from sale of one MBF of mature timber		
	<u>B/C</u>	Ratio @ <u>6%</u>	=	<u>.40</u>
		Present net worth @ <u>6%</u>	=	<u>\$ -100</u>

Code	<u>\$100</u>	Cost of PCT one acre		
	<u>10</u>	Cost to sell one MBF of mature timber		
	<u>20</u>	Income from sale of one MBF of mature timber		
	<u>B/C</u>	Ratio @ <u>6%</u>	=	<u>.80</u>
		Present net worth @ <u>6%</u>	=	<u>\$ -33.50</u>

Code	<u>\$100</u>	Cost to PCT one acre		
	<u>10</u>	Cost to sell one MBF of mature timber		
	<u>40</u>	Income from sale of one MBF of mature timber		
	<u>B/C</u>	Ratio @ <u>6%</u>	=	<u>1.60</u>
		Present net worth @ <u>6%</u>	=	<u>\$ 99.5</u>

Code	<u>\$100</u>	Cost of PCT one acre		
	<u>10</u>	Cost to sell one MBF of mature timber		
	<u>80</u>	Income from sale of one MBF of mature timber		
	<u>B/C</u>	Ratio @ <u>6%</u>	=	<u>3.20</u>
		Present net worth @ <u>6%</u>	=	<u>\$ 365.49</u>

1/ Site Index 60 Lodgepole pine is generally clear-cut and can be regenerated naturally; therefore, no reforestation costs were included in the above B/C analysis. If you wish to include reforestation costs of \$50.00 per acre, note that this is equivalent to adding \$5.00 per MBF to the cost of selling timber.

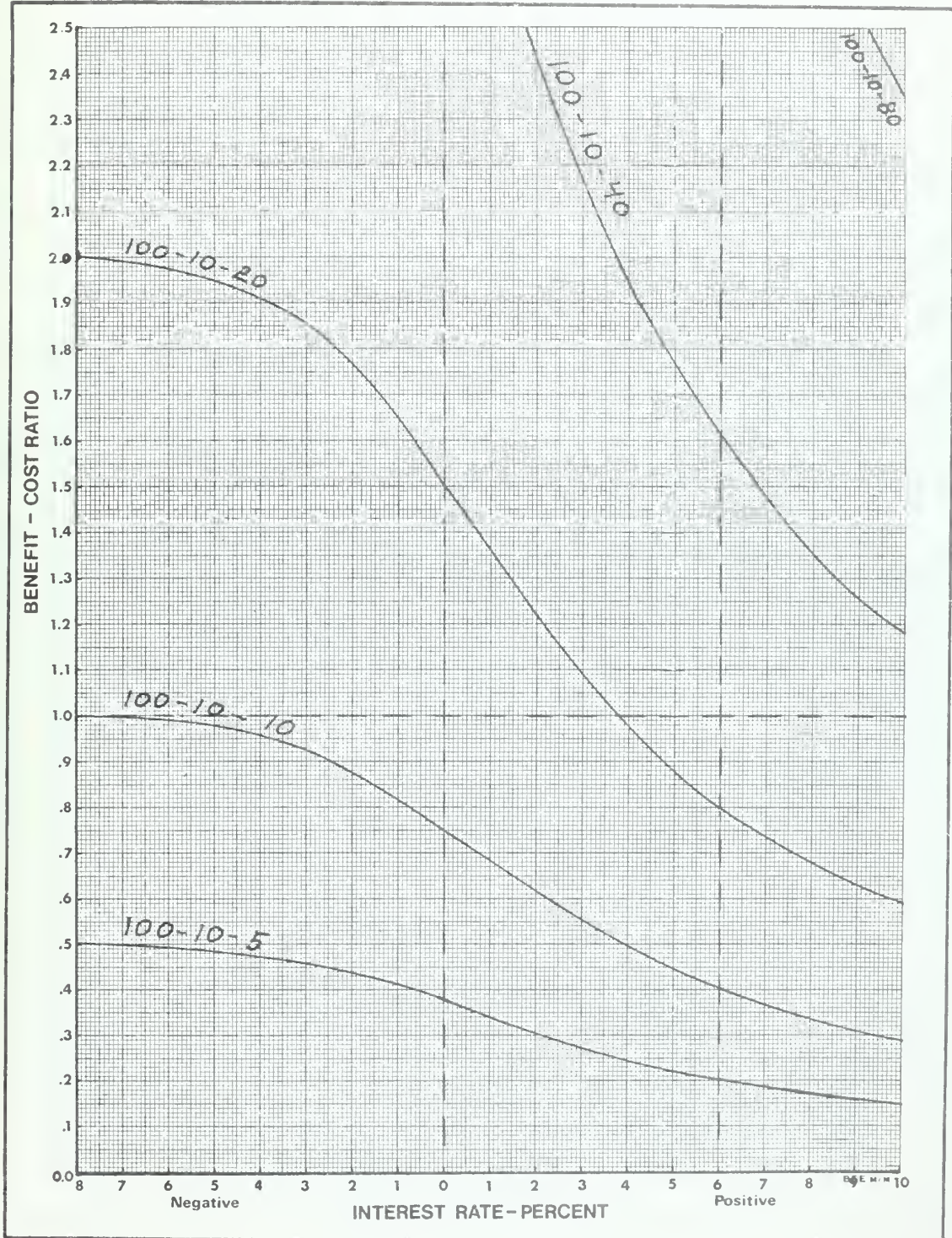
# BENEFIT/COST RATIO

## Alternatives

100-10-(5-10-20-40-80)

Lodgepole Pine--Site Index 60

Precommercial Thin Only--@ 20 Years of Age



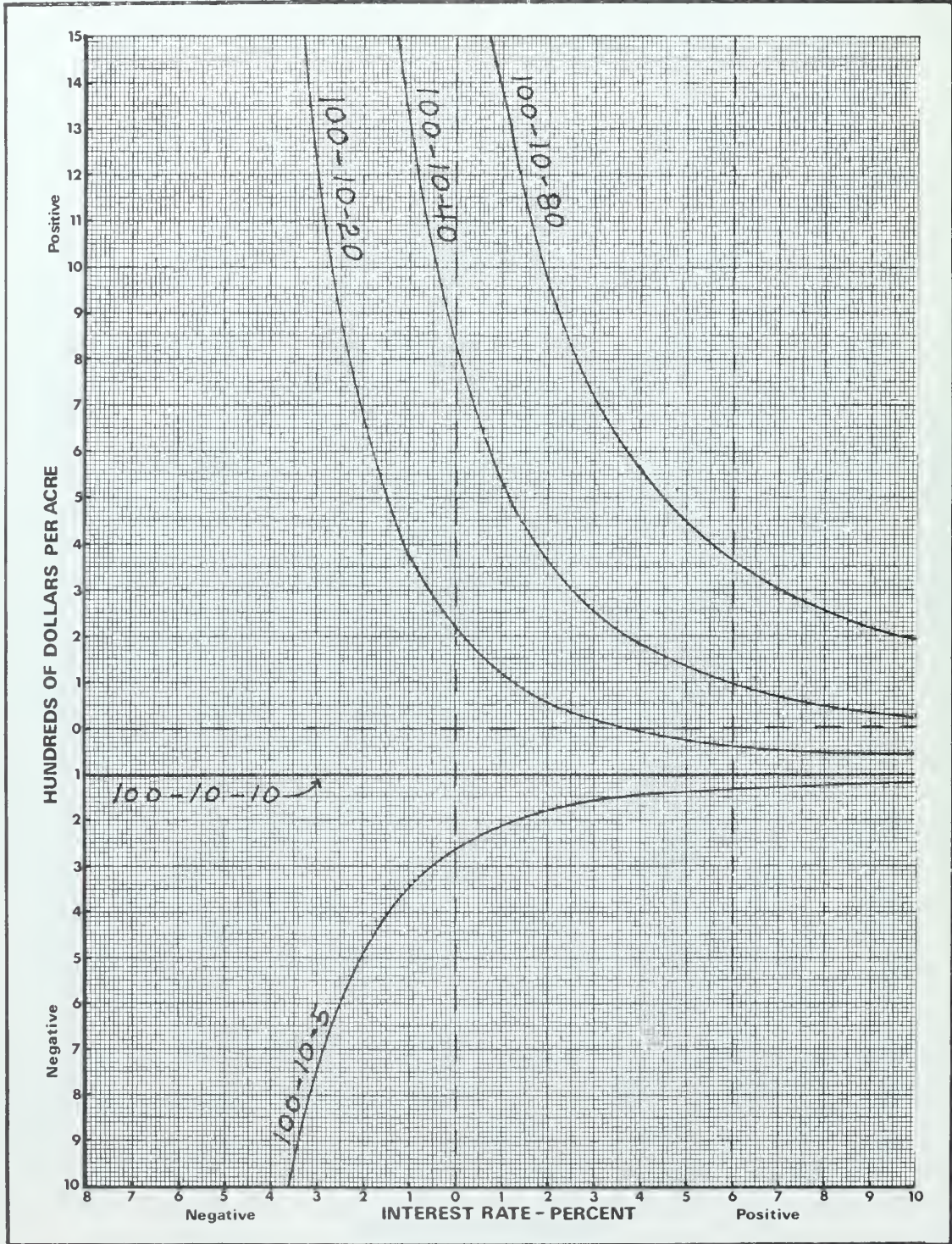
# PRESENT NET WORTH

## Alternatives

100-10-(5-10-20-40-80)

Lodgepole Pine--Site Index 60

Precommercial Thin Only--@ 20 Years of Age



BENEFIT-COST ANALYSIS--PRECOMMERCIAL THIN @ AGE 20 ONLY

PROBLEM NO. 2 LUDGEPOLE PINE/ SITE INDLX 60/ FINAL HARVEST @ 100 YEARS/ HORAK

BENEFIT-COST RATIO (B/C) AT ALTERNATIVE RATES OF INTEREST  
PRESENT NET WORTH (PNW) AT ALTERNATIVE RATES OF INTEREST

RATE	10010-05			10010-10			10010-20			10010-40			10010-80		
	*PNW	B/C*	B/C*	*PNW	B/C*	B/C*	*PNW	B/C*	B/C*	*PNW	B/C*	B/C*	*PNW	B/C*	B/C*
-10.00	-78352.90	0.50	1.00	-100.00	1.00	2.00	156405.81	2.00	4.00	469417.42	4.00	1095440.65	7.99	7.99	7.99
-9.00	-36408.76	0.50	1.00	-100.00	1.00	2.00	72517.51	2.00	3.99	217752.54	3.99	508222.59	7.99	7.99	7.99
-8.00	-17313.70	0.50	1.00	-100.00	1.00	1.99	34327.41	1.99	3.99	103182.23	3.99	240891.86	7.98	7.98	7.98
-7.00	-8459.75	0.50	0.99	-100.00	0.99	1.99	16619.50	1.99	3.98	50058.49	3.98	116936.48	7.95	7.95	7.95
-6.00	-4272.68	0.49	0.99	-100.00	0.99	1.98	8245.35	1.98	3.95	24936.06	3.95	58317.48	7.91	7.91	7.91
-5.00	-2249.74	0.49	0.98	-100.00	0.98	1.95	4199.44	1.95	3.91	12798.45	3.91	29996.39	7.82	7.82	7.82
-4.00	-1249.12	0.48	0.96	-100.00	0.96	1.92	2195.24	1.92	3.83	6794.72	3.83	15947.68	7.67	7.67	7.67
-3.00	-741.10	0.46	0.93	-100.00	0.93	1.86	1142.19	1.86	3.71	3746.58	3.71	8675.36	7.42	7.42	7.42
-2.00	-475.57	0.44	0.88	-100.00	0.88	1.77	651.13	1.77	3.53	2153.40	3.53	5157.93	7.06	7.06	7.06
0.00	-332.21	0.41	0.82	-100.00	0.82	1.65	364.43	1.65	3.29	1293.28	3.29	3150.99	6.58	6.58	6.58
1.00	-252.00	0.38	0.75	-100.00	0.75	1.50	204.00	1.50	3.01	812.00	3.01	2028.00	6.02	6.02	6.02
2.00	-205.33	0.34	0.68	-100.00	0.68	1.36	110.66	1.36	2.71	531.98	2.71	1374.63	5.42	5.42	5.42
3.00	-177.02	0.30	0.61	-100.00	0.61	1.21	54.05	1.21	2.43	362.15	2.43	978.35	4.85	4.85	4.85
4.00	-159.10	0.27	0.54	-100.00	0.54	1.08	18.21	1.08	2.17	254.62	2.17	727.44	4.33	4.33	4.33
5.00	-147.26	0.24	0.49	-100.00	0.49	0.97	-5.49	0.97	1.94	163.54	1.94	561.60	3.89	3.89	3.89
6.00	-139.09	0.22	0.44	-100.00	0.44	0.88	-21.81	0.88	1.76	134.57	1.76	447.33	3.51	3.51	3.51
7.00	-133.25	0.20	0.40	-100.00	0.40	0.80	-33.50	0.80	1.60	99.50	1.60	365.49	3.20	3.20	3.20
8.00	-128.91	0.18	0.37	-100.00	0.37	0.73	-42.17	0.73	1.47	73.48	1.47	304.79	2.93	2.93	2.93
9.00	-125.60	0.17	0.34	-100.00	0.34	0.68	-46.81	0.68	1.35	53.57	1.35	258.34	2.71	2.71	2.71
10.00	-122.99	0.16	0.31	-100.00	0.31	0.63	-54.02	0.63	1.26	37.93	1.26	221.83	2.52	2.52	2.52
11.00	-120.89	0.15	0.29	-100.00	0.29	0.59	-58.22	0.59	1.18	25.34	1.18	192.46	2.36	2.36	2.36
12.00	-119.17	0.14	0.28	-100.00	0.28	0.55	-61.66	0.55	1.11	15.01	1.11	168.35	2.22	2.22	2.22
13.00	-117.73	0.13	0.26	-100.00	0.26	0.52	-64.54	0.52	1.05	6.39	1.05	148.24	2.09	2.09	2.09
14.00	-116.51	0.12	0.25	-100.00	0.25	0.50	-66.97	0.50	0.99	-0.91	0.99	131.20	1.99	1.99	1.99
15.00	-115.47	0.12	0.24	-100.00	0.24	0.47	-69.06	0.47	0.95	-7.17	0.95	116.59	1.89	1.89	1.89
16.00	-114.57	0.11	0.23	-100.00	0.23	0.45	-70.87	0.45	0.90	-12.60	0.90	103.93	1.80	1.80	1.80

Present Net Worth  
Benefit/Cost Ratio  
100-15-(5-10-20-40-80)  
Lodgepole Pine--Site Index 60

Precommercial Thin Only--At 20 Years of Age

Average stand volume-mature timber	20,000	Bd. Ft. acre
Increase in volume due to thinning	30,400	Bd. Ft. acre
Investment period	80	Years
Annual allowable cut increment increase	380	Bd. Ft.
Additional acreage cut and reforested <u>1/</u>	0.019	Acres
Cost of reforestation @\$50.00 per acre <u>1/</u>	\$0.95	Annually

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Code <u>\$100</u>	Cost to PCT one acre		
<u>15</u>	Cost to sell one MBF of mature timber		
<u>5</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio	@ 6%	= 0.17
Present net worth	@ 6%		= \$ <u>-166.50</u>

---

Code <u>\$100</u>	Cost to PCT one acre		
<u>15</u>	Cost to sell one MBF of mature timber		
<u>10</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio	@ 6%	= 0.33
Present net worth	@ 6%		= \$ <u>-133.25</u>

---

Code <u>\$100</u>	Cost of PCT one acre		
<u>15</u>	Cost to sell one MBF of mature timber		
<u>20</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio	@ 6%	= 0.67
Present net worth	@ 6%		= \$ <u>-66.75</u>

---

Code <u>\$100</u>	Cost to PCT one acre		
<u>15</u>	Cost to sell one MBF of mature timber		
<u>40</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio	@ 6%	= 1.33
Present net worth	@ 6%		= \$ <u>66.33</u>

---

Code <u>\$100</u>	Cost of PCT one acre		
<u>15</u>	Cost to sell one MBF of mature timber		
<u>80</u>	Income from sale of one MBF of mature timber		
<u>B/C</u>	Ratio	@ 6%	= 2.64
Present net worth	@ 6%		= \$ <u>332.24</u>

---

1/ Site Index 60 Lodgepole pine is generally clear-cut and can be regenerated naturally; therefore, no reforestation costs were included in the above B/C analysis. If you wish to include reforestation costs of \$50.00 per acre, note that this is equivalent to adding \$5.00 per MBF to the cost of selling timber.



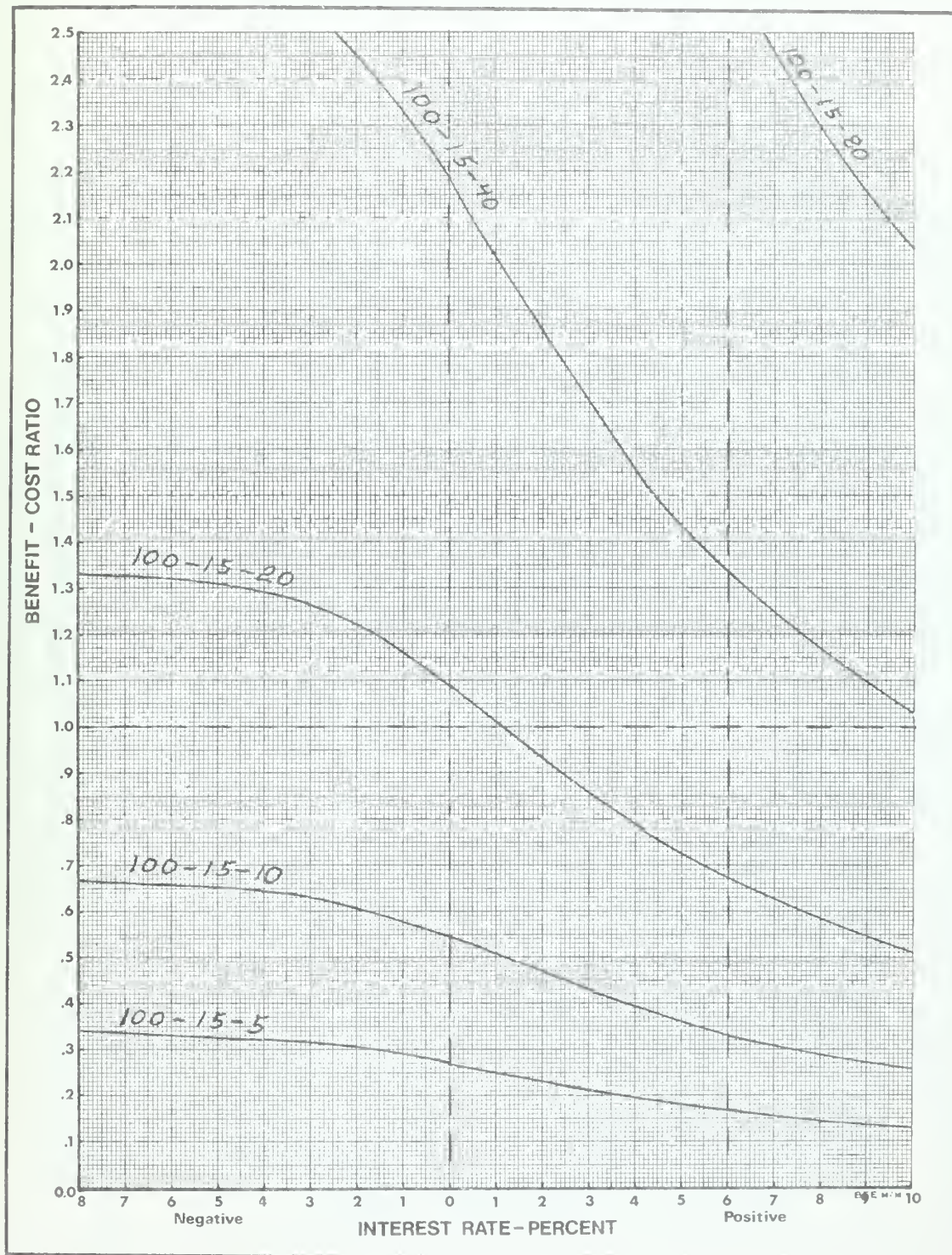
# BENEFIT/COST RATIO

## Alternatives

100-15-(5-10-20-40-80)

Lodgepole Pine--Site Index 60

Precommercial Thin Only--@ 20 Years of Age



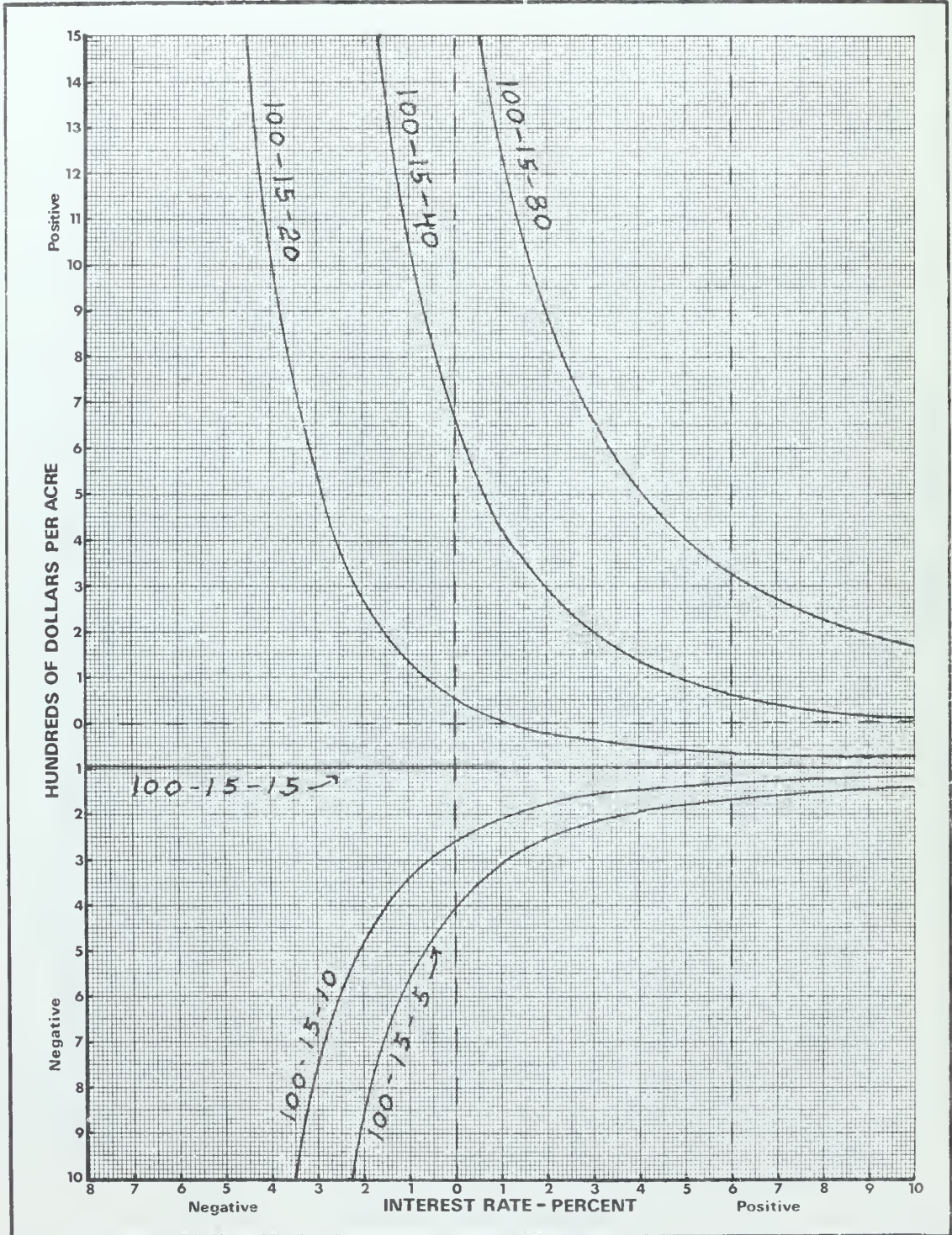
# PRESENT NET WORTH

## Alternatives

100-15-(5-10-20-40-80)

Lodgepole Pine--Site Index 69

Precommercial Thin Only--@ 20 Years of Age



BENEFIT-COST ANALYSIS--PRECOMMERCIAL THIN @ AGE 20 ONLY  
 LODGEPOLE PINE; SITE INDEX 60; FINAL HARVEST @ 100 YEARS; HORAK

BENEFIT-COST RATIO (B/C) AT ALTERNATIVE RATES OF INTEREST  
 PRESENT NET WORTH (PNW) AT ALTERNATIVE RATES OF INTEREST

RATE	10015-05			10015-10			10015-20			10015-40			10015-80		
	*PNW	B/C*	*PNW	B/C*	*PNW	B/C*	*PNW	B/C*	*PNW	B/C*	*PNW	B/C*	*PNW	B/C*	
-10.00	-156605.81	0.33	-79352.90	0.67	78152.90	1.33	391164.52	2.67	1008950.60	5.30					
-9.00	-72717.51	0.33	-36408.76	0.67	36208.76	1.33	181443.78	2.66	468091.86	5.29					
-8.00	-34527.41	0.33	-17313.70	0.67	17113.70	1.33	85968.52	2.66	221866.19	5.29					
-7.00	-16819.50	0.33	-8459.75	0.66	8259.75	1.33	41698.74	2.66	107696.76	5.28					
-6.00	-8445.35	0.33	-4272.68	0.66	4272.68	1.32	20763.39	2.65	53705.57	5.26					
-5.00	-4399.48	0.33	-2249.74	0.66	2049.74	1.31	10648.71	2.63	27620.36	5.22					
-4.00	-2398.24	0.32	-1249.12	0.65	1049.12	1.30	5645.60	2.59	14171.60	5.15					
-3.00	-1382.19	0.32	-741.10	0.63	541.10	1.27	3105.49	2.53	8166.78	5.04					
-2.00	-851.13	0.31	-475.57	0.61	275.57	1.22	1777.83	2.45	4742.83	4.87					
-1.00	-564.43	0.29	-332.21	0.58	132.21	1.17	1061.07	2.33	2494.33	4.63					
0.00	-404.00	0.27	-252.00	0.55	52.00	1.09	660.00	2.19	1860.00	4.35					
1.00	-310.66	0.25	-205.33	0.51	5.33	1.01	426.65	2.03	1258.21	4.02					
2.00	-254.05	0.23	-177.02	0.47	-22.98	0.93	285.12	1.86	893.22	3.70					
3.00	-218.21	0.21	-159.10	0.43	-40.90	0.85	195.51	1.71	662.12	3.39					
4.00	-194.51	0.20	-147.26	0.39	-52.74	0.78	136.28	1.56	509.36	3.11					
5.00	-178.19	0.18	-139.09	0.36	-60.91	0.72	95.47	1.44	404.12	2.86					
6.00	-166.50	0.17	-133.25	0.33	-66.75	0.67	66.25	1.33	328.74	2.65					
7.00	-157.83	0.15	-128.91	0.31	-71.09	0.62	44.57	1.24	272.83	2.46					
8.00	-151.19	0.14	-125.60	0.29	-74.40	0.58	27.98	1.16	230.05	2.30					
9.00	-145.98	0.14	-122.99	0.27	-77.01	0.54	14.94	1.07	196.42	2.16					
10.00	-141.78	0.13	-120.89	0.26	-79.11	0.51	4.45	1.03	169.37	2.04					
11.00	-138.34	0.12	-119.17	0.24	-80.83	0.49	-4.16	0.97	147.17	1.93					
12.00	-135.46	0.12	-117.73	0.23	-82.27	0.46	-11.34	0.93	128.64	1.84					
13.00	-133.03	0.11	-116.51	0.22	-83.49	0.44	-17.43	0.88	112.95	1.76					
14.00	-130.94	0.11	-115.47	0.21	-84.53	0.42	-22.65	0.85	99.49	1.68					
15.00	-129.13	0.10	-114.57	0.20	-85.43	0.41	-27.17	0.81	87.03	1.61					

## IX. Interpolation Procedures

Only rarely will a forester find that his set of field data coincides directly with a set of the sample data given in Chapter VIII. In most cases, the forester will have to apply interpolation procedures to develop a series of points between the terms given in the examples.

### A. Interpolation Factors

#### 1. Site Quality

Two levels of site qualities are given for proposed precommercial thinning projects. Report #1 covers site index 40 and Report #2 covers site index 60 forests of lodgepole pine. Several steps are inferred when a given site quality is analyzed. These are:

The productivity of untreated, stagnated stands must be developed from stand projections, stand examinations or research notes, etc.

The yield and growth of treated stands must be developed from stand prescriptions, stand examinations or research data, etc.

The average yield per acre of the existing forest must be computed from inventory data. Second degree equations must be developed from polynomial regressions of stand volume over stand age.

The amount of the annual increase in the allowable cut is computed from forest simulation models by using the "with and without" concepts of forest management.

The additional annual acreage cutover due to the proposed "with" action must be computed.

The biological data noted above generally follow logarithmic curve values. Extensions of values past the 40 to 60 site index range of data shown should follow the same curved trends.

#### 2. Average Thinning Cost

Precommercial thinning costs, in the samples given, are fixed at \$25.00, \$50.00, \$75.00 and \$100.00 per acre. The reviewer may also extend curve values past the ranges shown. This is a one time immediate cost which is not affected by long term discount interest rates.

### 3. Selling Expenses

The sum of the expenses of offering timber for sale and administering the sale are given in fixed amounts of \$5.00, \$10.00, \$15.00, \$20.00 and \$25.00 per thousand board feet. This cost occurs annually. Review District or State Office records for costs and trends in administrative costs.

### 4. Selling Price

The income received from the sale of timber includes the dollars received plus the capital investment in the lands involved. The samples given are graduated on a scale which doubles the previous price so that the analyst can proportion his income directly between the sample values shown. Selling price examples are shown at \$5.00, \$10.00, \$20.00, \$40.00, and \$80.00. These are annual incomes which terminate after 80 years.

#### B. Field Test For Site Index 60 Lands

If the forester finds the following represents conditions in his District and the timber stand being analyzed for treatment:

- Site index for lodgepole pine is approximately 60.
- Average thinning cost is \$85.00 per acre.
- Expenses for selling timber are approximately \$12.00 per thousand board feet.
- Average selling price of mature timber is \$35.00 per thousand board feet.
- Appraisal studies show that the capital investment in roads is \$5.00 per thousand board feet.
- Adequate natural regeneration is anticipated.

Then he must follow Steps 1, 2 and 3 as listed below:

Step 1. Interpolate a B/C ratio curve for a selling expense of \$12.00:

- a. Draw a 75-10-40 curve.

- b. Draw a 75-15-40 curve.
- c. Proportion a 75-12-40 curve between the a and b curves above. The B/C ratio at 6% interest should be approximately 1.74.

Step 2. Interpolate another B/C ratio curve for the \$12.00 selling expense:

- a. Draw a 100-10-40 curve.
- b. Draw a 100-15-40 curve.
- c. Proportion a 100-12-40 curve between the a and b curves above. The B/C ratio at 6% interest rate should be approximately 1.49.

Step 3. Interpolate a curve for the \$85.00 thinning cost between the 75-12-40 and the 100-12-40 B/C ratio curves that you just developed. The B/C ratio at 6% interest rate should be approximately 1.64.

### C. Field Tests for Other Site Indices

When the site quality is either 40 or 60, Economic Analysis Reports #1 and 2 may be used directly. However, when an analysis of a stand growing on site quality land other than 40 or 60 is required, two more interpolation steps are required.

#### 1. First Step

Use the procedure described in B (above) and develop the B/C ratio curves as if the site quality was exactly 60.

#### 2. Second Step

Use the procedure as described in Report #1 and develop the B/C ratio curves as if the site quality was exactly 40.

#### 3. Finish

Proportion a third curve representing your exact site index between the two B/C ratio curves developed in Steps #1 and 2 above. This B/C ratio is adequate to determine if the project should be developed further or abandoned as non-feasible.

## X. Endorsement of Projects

Timber stand improvement projects designed to increase the supply of timber must show that the majority of benefits received apply to the timber management function. The analysis must include benefits and costs from both timber and all other multiple-use disciplines. Only the primary benefits and costs may be considered in the initial analysis.

A. Silvicultural projects with a timber production benefit/cost ratio of 0.5 or less obviously would have to be justified, financed and administered by one of the other multiple use disciplines. Reforestation, stand conversion, thinning, cleaning, etc. projects, while carried out on forest land, may be designed to be of primary benefit for wildlife, watershed protection, recreation or range management purposes.

B. Intensive timber management proposals with a benefit/cost ratio of between 0.5 and 1.0 (for timber production only) may deserve a closer scrutiny of the prescription design and the methodology involved. It may be possible to redesign the proposal so that a more favorable analysis results. Direct benefits and costs occurring to other multiple use disciplines must then be examined. The sum of all benefits may then show that the project falls within a favorable or feasible category.

C. Projects which show a favorable economic analysis for timber production (those with a benefit/cost ratio of over 1.0) must also be examined for their affect upon other multiple-use disciplines.

Projects with a favorable timber benefit/cost ratio may be realigned in their order of priority upon completion of studies of the multiple use benefits and costs attributable to each of the other disciplines affected.

Recommended proposal becomes part of the program package section of BLM 1630, Annual Work Plan Submissions and they may be funded as a part of BLM 5100 Timber Management Planning Activities.

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